the Mecheleciv

VOL. 16 NO. 3

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SCHOOL OF ENGINEERING
THE GEORGE WASHINGTON UNIVERSITY

DECEMBER 1956

Thomas A. Beattie, class of '47,
speaks from experience when he says:

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In this position, Mr. Beattie's responsibilities are numerous. They include the Service Power House and Skelp Mill area; maintenance of four blast furnaces and blast furnace auxiliaries, plus a sintering plant; maintenance of two blooming mills and soaking pits; maintenance of one bar mill; maintenance of three Bessemer converters, three open hearth furnaces, three open hearth auxiliaries, and seventy overhead cranes ranging from two to 200 tons. He supervises 680 men.

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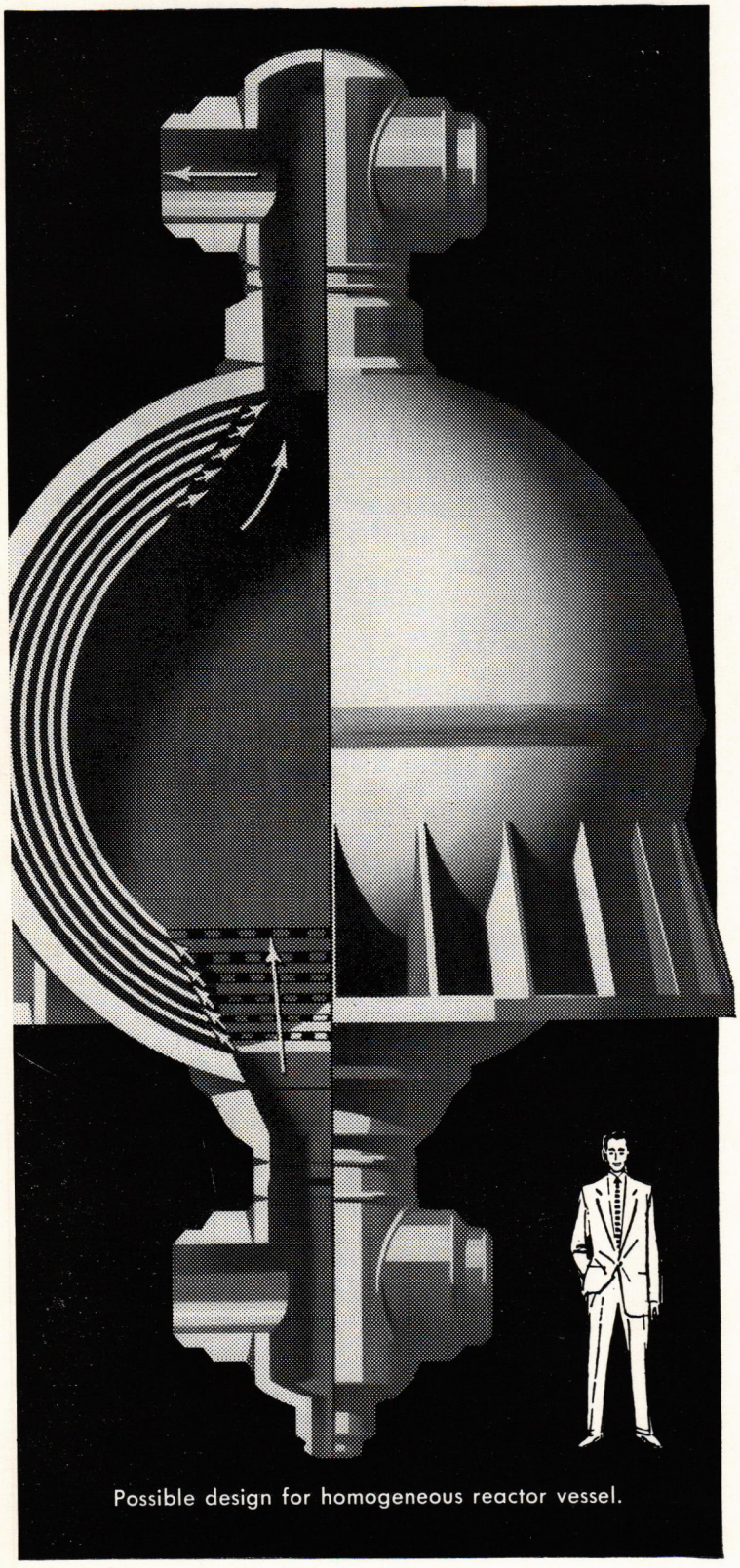

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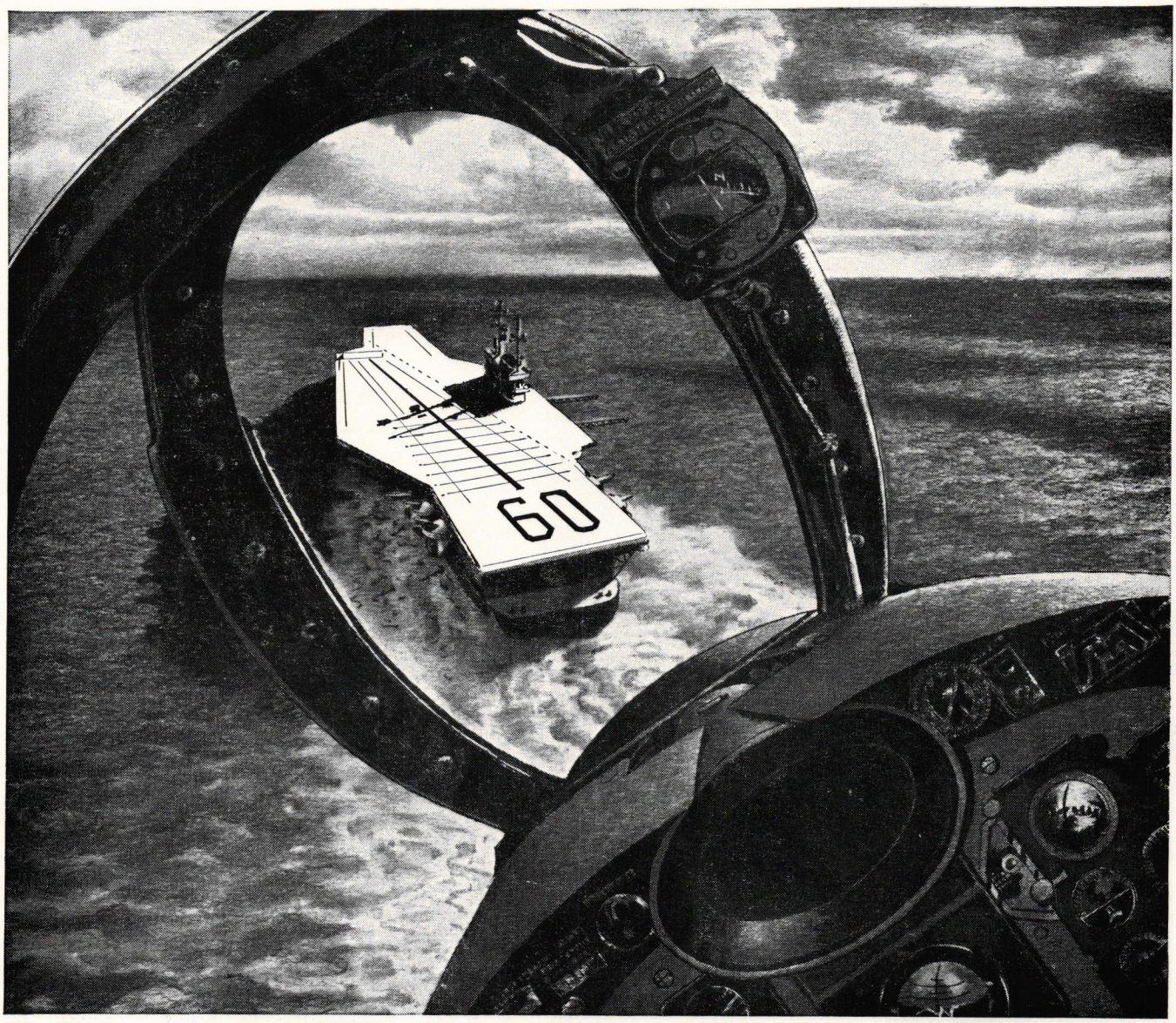

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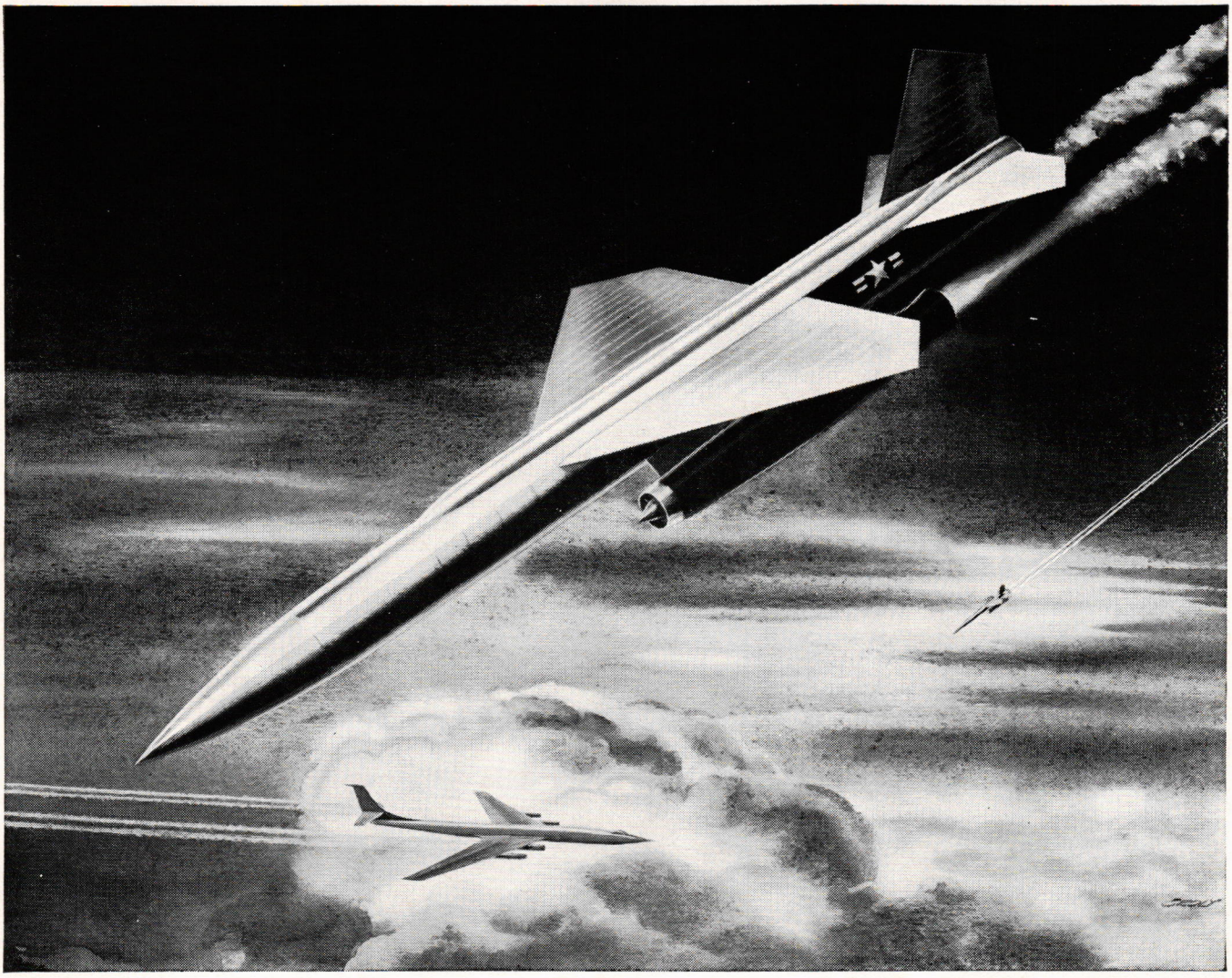

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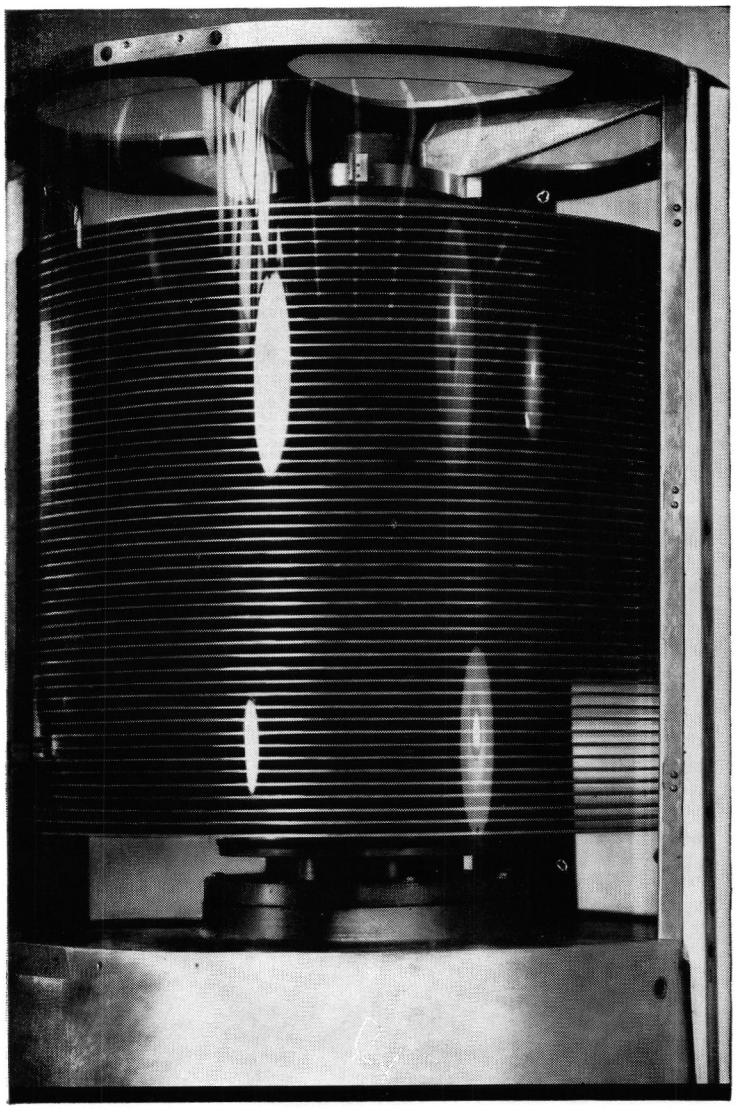

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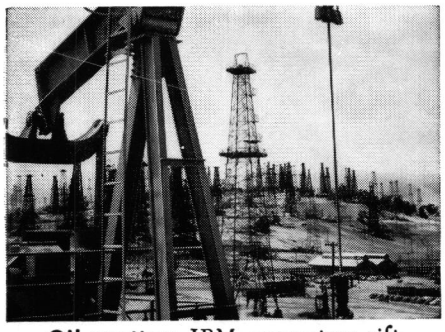

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VOL. 16 DECEMBER 1956 NO. 3

SCHOOL OF ENGINEERING, THE GEORGE WASHINGTON UNIVERSITY

IN THIS ISSUE

DEPARTMENTS

ON OUR COVER

ARMY H-32 RAM JET HELICOPTER IN FLIGHT.
U.S. Army Photograph

FRONTISPIECE

"VULCAN" GUN SHOWN TEST FIRING AT NIGHT.
(See page 24) *Cut courtesy of G. E.*

Published at the George Washington University by direction of the Engineers' Council. Published six times during the school year in October, November, December, March, April, and May. Entered as second class matter March 6, 1951, at the Post Office at Washington, D. C., under the act of March 3, 1879. Address communications to Mecheleciv Magazine, Davis-Hodgkins House, George Washington University, Washington 6, D. C. or telephone STerling 3-0250, Extension 528.

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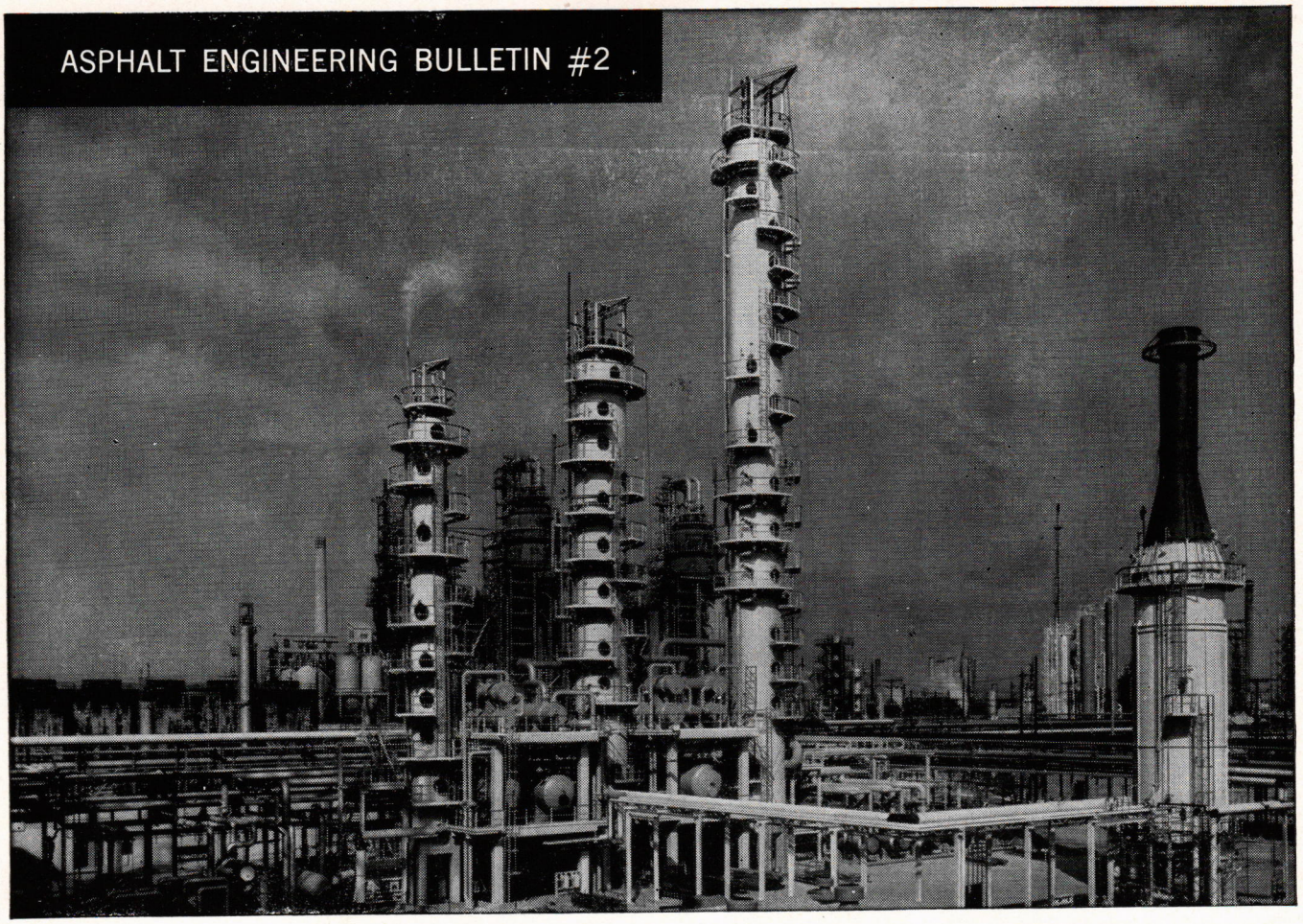

An array of standard types and grades of Asphalt comes from refineries in volume for a wide variety of engineering and industrial applications.

Asphalt is a versatile family of materials

"ASPHALT" denotes a class of material produced from crude petroleum . . . it is inherently durable, waterproof and adhesive.

Asphalt is produced in a variety of consistencies from hard solids to liquids. The harder types are called *Asphalt cements*. The more fluid types are called *liquid Asphaltic materials*.

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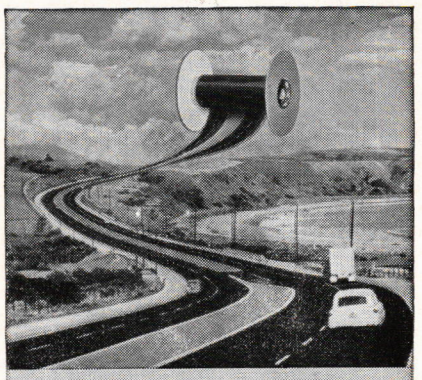
The emulsified Asphalts consist of minute Asphalt globules suspended in chemically-treated water. Also, in three standard types: Rapid Setting, Medium Setting, Slow Setting. When deposited upon stone or soil, as in road construction, the emulsions "break," allowing the water to escape and leaving an Asphalt film on the aggregate. Names of the types indicate relative rates at which their Asphalt globules coalesce.

Study the characteristics and applications of Asphalt. *Keep a complete file of these bulletins.*



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Charles H. Tompkins

EDITORIAL

If You Would See His Monument, Look Around

Christopher Wren

Sometime during the year of 2056, the Vault for the Future in the front of Tompkins Hall of Engineering will be opened in celebration of the building's centennial and engineers of that future time will find some of the fruits of the field of engineering in this present age. It is fervently hoped that during that same year some of the students, faculty, or alumni find it possible to give some thought to the person who made all this possible. It will also be the hundredth anniversary of his death, for Charles H. Tompkins passed away on December 12, 1956.

In the early part of this century, Mr. Tompkins and his wife founded the construction company which bears his name. The company grew from an initial contract of $6.00 for repairing the coping on a downtown drugstore to million-dollar contracts in many phases of construction.

Typical of many men who rise from humble beginnings to enjoy phenomenal material success, Mr. Tompkins was most generous in giving of his time to civic and philanthropic activities. For this he was well-known and well-loved throughout the community. The usually staid editorial writers of the Washington newspapers referred to him as "Charlie" Tompkins in their eulogies.

Charles Tompkins only attended night classes in engineering for a few semesters at The George Washington University but he took a deep interest in the University. He served as a Trustee for many years and, even though he was too eager to get started on his life's work to wait for his baccalaureate degree in his youth, he was awarded the honorary Doctor of Engineering degree in 1946. He capped these achievements and honors by donating our new engineering building to the University, asking only (so the story goes) where the University wanted it.

Mr. Tompkins life exemplifies the finest ideals of the field of engineering. His passing leaves a gap in the ranks of engineers which can only be filled by one who is a fine gentleman, dedicated civic leader, and superlative engineer. Those of us just entering the field would do well to emulate him.

R. J. S.

many moons

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TOMORROW'S TRANSPORTATION

SMALL ROTARY-WING AIRCRAFT

By Howell Crim B.M.E. '57

Man's age old dream of a practical, highly maneuverable, low cost, flying machine will be a reality within the immediate future if present work is continued. When it is, it will not be an overnite occurrence or the result of one man's efforts. It will however be some form of rotary-wing aircraft because of the great maneuverability advantage this type enjoys over fixed-wing aircraft.

The basic principle of rotary-wing flight may be traced to Leonardo Da Vinci's experiments with the Chinese top. It has progressed through many minds and thousands of designs.

In 1910 Igor Sikorsky built a 25-hp. machine which raised itself from the ground but was unstable. While Sikorsky temporarily turned to airplane development, many others experimented in the field and in 1937 the German designer Heinrich Foxe completed a machine which flew successfully at 70 mph. and to an altitude of 11,700 ft. and even flew inside a Berlin sports palace. The outbreak of war in Germany halted further development of this machine. In late 1939 Sikorsky successfully flew the VS-300 which was the first prototype of present day helicopters.

The comparatively slow development of the helicopter as compared to the great strides made in fixed-wing aircraft may be traced directly to the complex mehanism required to make it do the things it does, namely to rise and descend vertically, to fly forward, backward or sideways or to hover motionless in one spot.

In order to understand the problems in small copter development it is necessary to have a basic understanding of helicopter flight principles. I shall therefore attempt to explain these principles using a single rotor, two-bladed machine with simple tail rotor.

The helicopter, like the airplane, depends on the forces of lift of an airfoil or wing to sustain it in the air; the only difference being that the helicopter moves its wing through the air without moving the fuselage. Thus, the helicopter obtains its lift through rotation of its rotor blades. There are two means by which this lift and therefore vertical motion may be controlled. The first is obviously to vary the rotational speed of the rotor. The second is to vary the pitch or angle of attack of the rotor blades with respect to the horizontal air flow. Both of these controls are used in the modern helicopter. The pitch control or more correctly the collective pitch control changes the pitch of each blade the same amount and is connected to the throttle so that as the pitch is varied the power of the engine is changed proportionately. This change in pitch is accomplished by means of push rods attached to the trailing edge of the rotor blade which revolve with the rotor on a horizontal disc. As the disc is moved vertically the push rods change the pitch of the blades. This, then, explains the vertical motion and control of a helicopter.

The next problem is that of horizontal flight. It is obvious that when the helicopter moves vertically the resultant vector of the rotor acts straight up as shown. It is also obvious that for the helicopter to move horizontally there must be a component of force acting in this direction. In order to obtain this horizontal component the resultant vector must be inclined to the vertical as shown. The only way to incline the resultant is to incline the plane of rotation of the rotor blades. Since it would be highly impractical to incline the axis of rotation of the drive shaft, the helicopter pilot utilizes what is called the cyclic pitch control. This control is different from the collective pitch control in that it varies the pitch of each blade as it passes a given point during each revolution of the rotor rather than changing the pitch of all blades collectively. When the helicopter pilot desires to fly forward he must incline the plane of rotation of the rotor so that it is down in front and up in back as shown in the diagram. If, therefore, he adjusts the cyclic pitch control so that as each blade approaches the rear of the craft its pitch is increased, the increased lift at this point will tilt the plane of rotation into the desired position and the craft will move forward. This same principle holds true for sideways or backward flight. The cyclic pitch is merely adjusted so that the plane of rotation is tilted in the direction of desired flight.

The cyclic pitch is obtained through the same push rods and disc that regulate collective pitch. The cyclic pitch control is connected to the disc so that the disc may be tilted with respect to the drive shaft, thus as the

Army H-32 Ram Jet Helicopter

push rods rotate they are raised on one side of the disc and lowered on the other thereby changing the pitch of the blade during each revolution.

One control remains to be discussed. That is the control of heading or rotation of the fuselage. First it must be understood that the engine applies a torque to the rotor and therefore there is an equal and opposite torque applied to the fuselage. If not checked, this torque would cause the helicopter to rotate in the air about its own driveshaft. In order to overcome this, a small propellor or rotor known as the anti-torque rotor is attached to the tail of the craft and rotated on a horizontal axis so as to oppose this torque. It is driven by the same engine as the main rotor and therefore changes in main rotor torque are automatically compensated for by changes in anti-torque rotor speed. It is obvious that this rotor may be used to control the heading of the craft by either over or under compensating for the main rotor torque. This is done by varying the pitch of the anti-torque rotor blades in the same manner as the collective pitch varies the pitch of the main rotor blades.

If this discussion of helicopter controls has not been entirely clear, it has at least given you a greater appreciation of the problems encountered by the helicopter engineer. Aside from vibration, one of the greatest problems is that of inertia loading of the rotor blades caused by changes in blade pitch and speed. This problem has been alleviated through the development of the spring loaded flap and drag hinges. The flap hinge allows the blade to move or flap in a vertical Plane and thus absorbs the shock of changes in blade pitch. The drag hinge allows the blade to move in a horizontal plane relative to the rotor hub and thus absorbs the shock of changes in blade speed. These hinges together with the mechanisms for collective and cyclic pitch control combine to make the rotor hub a very complex and costly assembly.

The next problem is obvious and is indeed most important. What happens to the helicopter in the event of engine failure? The immediate result is that lift is greatly reduced and the aircraft begins to fall. The air flow through the rotor blades which normally is from top to bottom is now reversed and flows up through the blades as the helicopter descends. If the pilot upon noting engine failure disengages the rotor from the engine and decreases the pitch of the rotor blades, the action known as autorotation takes place and the rotor continues to rotate in the same direction. This rotation now caused by the upward flow of air through the blades creates sufficient lift to allow the craft to glide to a safe and fully controlled landing. It is this feature of autorotation which, when combined with its maneuverability, makes the helicopter a safer vehicle than its fixed wing counterpart. This fact is verified by the C.A.A. and will be pointed out.

It is obvious that the transition from powered to autorotative flight is not instantaneous and therefore can be carried out only if the aircraft has sufficient altitude. This then introduces a critical period in helicopter flight during take-off and landing while the aircraft is at altitudes where conversion to autorotative flight could not be carried out in sufficient time to prevent a crash, in the event of engine failure. The critical period during landing may be easily overcome by intentionally landing under autorotation where the transition is made at a safe altitude. In the event of pilot error or misjudgement during an autorotative landing the engine may be quickly engaged and the landing approach repeated.

(Please turn to page 40.)

TRANSISTOR EQUIVALENT CIRCUITS

By John P. Barranger B.E.E. '57

In 1948, Bell Laboratories announced that they had amplified a small electric current through the use of a doped semiconductor. This first type of transistor commonly called the point contact transistor was simply a block of germanium into which was imbedded two catswhiskers. The rapidly expanding field of transistor electronics soon brought forth the junction transistor, the type most commonly used today. The transistor's low power consumption and small size are probably the most important of its many advantages. They have been used as amplifiers, oscillators and electronic switches as well as in many other applications. Some commercially available radios, portable transmitters and electronic computers are now using transistor circuits.

Before the designer can use a device as part of a circuit he has to break the device down to known circuit elements. This is the only way he can mathematically predict how the circuit will act when he unites the device and the remaining elements of the circuit. An equivalent circuit is an electrical analogy in terms of known resistances, inductors and capacitors. Since the transistor is an active network it must also have at least one generator in the equivalent circuit. It is my purpose to discuss the various transistor equivalent circuits and to explain their limitations.

The Transistor

The physical transistor, Figure 1 (a) may be represented by the symbol in Figure 1 (b). To operate as an amplifier a p-n-p type of junction transistor must have the bias voltages with respect to the base of the polarities shown in the diagram. An n-p-n transistor requires voltages of the opposite polarity. For those unfamiliar with the device the transistor may be compared generally to the vacuum tube shown in Figure 1 (c), the base to the grid, the collector to the plate and the emitter to the cathode. The duality is incomplete however, since the transistor is essentially a current amplifying device whereas the vacuum tube is essentially an amplifier of voltage.

The electric network representation of the transistor cannot be made as simple as that of the vacuum tube. In the latter case a voltage generator in series with a resistance represents the small signal equivalent circuit of a tube at low frequencies. One of the reasons for the difference in behavior is that whereas there is a considerable degree of isolation between the input and the output of a vacuum tube, such isolation does not exist with the transistor. A more general approach must be used to describe the equivalent network of a transistor.

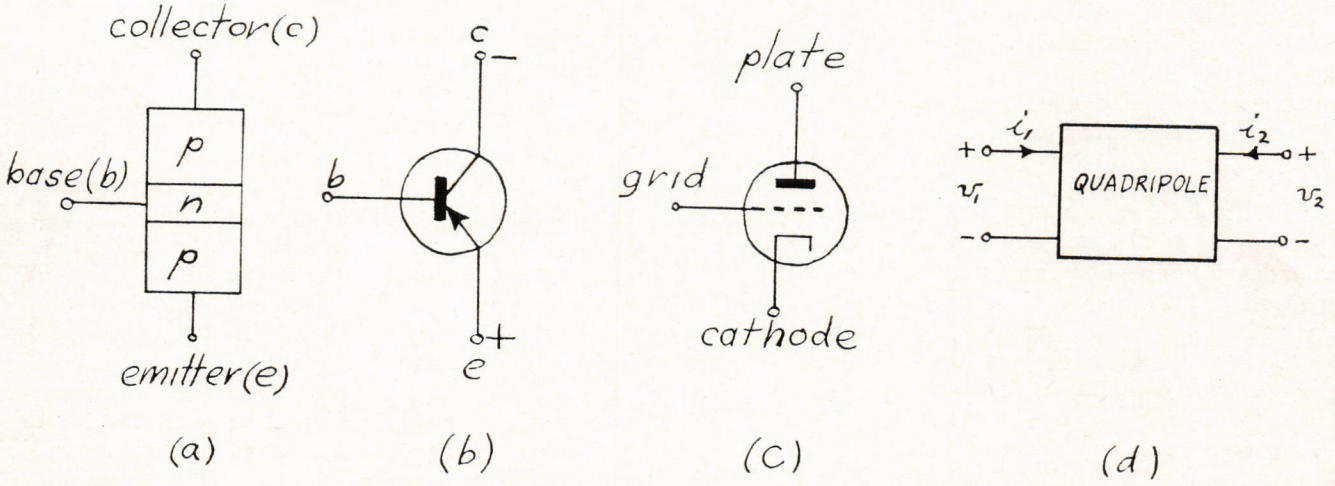


Figure 1. Transitor and Tube Symbols

The Quadripole

Most of the common equivalent circuits found in electrical engineering are based on the quadripole or four terminal active network, illustrated in Figure 1 (d). The circuit properties of the transistor can be described by a pair of simultaneous equations relating four variables v_1, v_2, i_1 and i_2. For the usual small signal operation, the equations are linear and coefficients of the variables are called parameters. In the transistor, these coefficients depend on the operating point but no serious errors result if they are assumed constant.

There are twelve possible equations that can be written from the quadripole but only six of these are of any practical value to transistor electronics. They may be described in terms of three sets of parameters: the z or impedance parameters, the y or admittance parameters and the h or hybrid parameters. A distinction is made between the device parameters and the circuit parameters. The former are parameters that have a significance in terms of the physics of the device, while the latter are measured parameters that relate terminal voltages and currents. Just as there are three common circuit configurations for the vacuum tube (grounded cathode, grounded grid, and grounded plate), there are also three configurations for the transistor. Circuit parameters are peculiar to a given configuration but if a complete set is derived for one configuration the circuit parameters for the others may be calculated using known relationships. Device parameters however, are independent of the circuit configuration in which the transistor may be used. In the following sections four general types of networks will be discussed: the z, y, and h equivalent circuits using the circuit parameters and the modified Tee circuit utilizing device parameters.

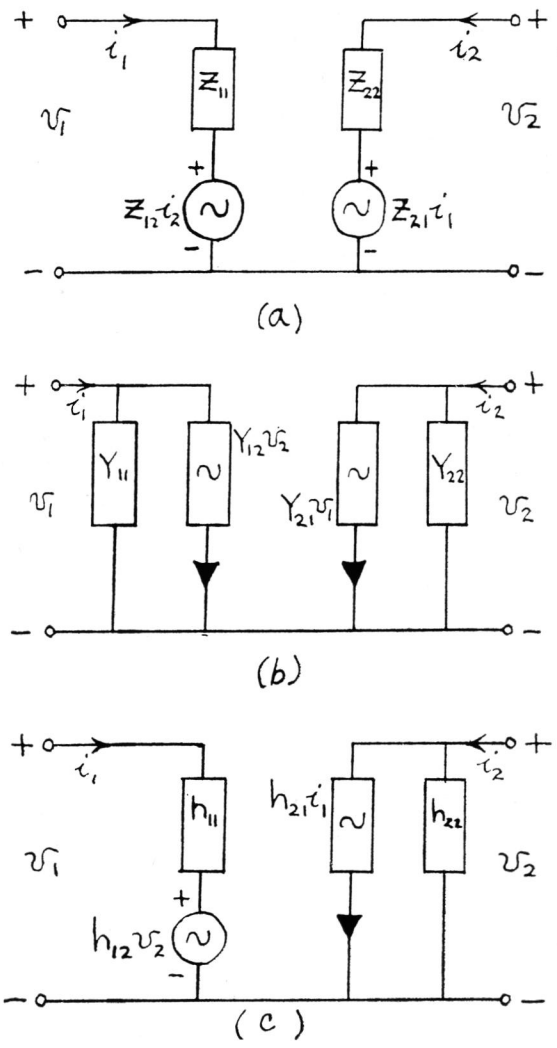


Figure 2. Equivalent circuits based on (a) z, (b) y, and (c) h parameters.

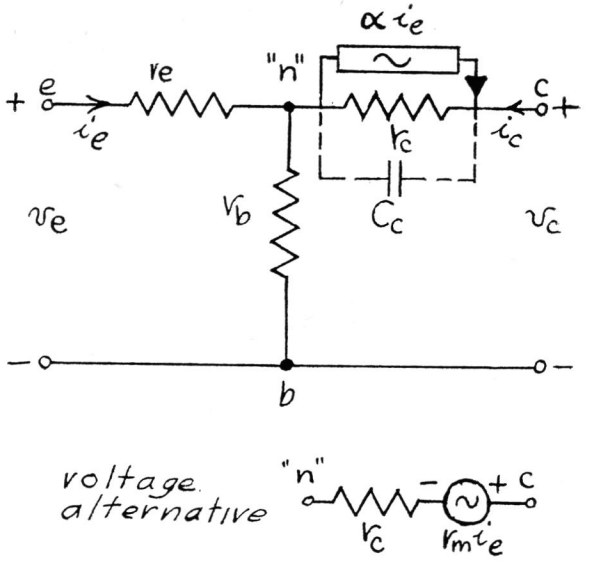


Figure 3. Modified Tee Equivalent Circuits.

Impedance Equivalent Circuit

Of the variables v_1, v_2, i_1 and i_2 it is convenient to assume i_1 and i_2 as the independent variables. To express v_1 and v_2 in terms of these variables requires the set of differential equations

$$dv_1 = \frac{\partial v_1}{\partial i_1} di_1 + \frac{\partial v_1}{\partial i_2} di_2$$

$$dv_2 = \frac{\partial v_2}{\partial i_1} di_1 + \frac{\partial v_2}{\partial i_2} di_2$$

For small signals the partial derivatives are treated as constants and the above equations reduce to

$$v_1 = z_{11} i_1 + z_{12} i_2 \qquad (1)$$

$$v_2 = z_{21} i_1 + z_{22} i_2 \qquad (2)$$

where the z_{11}, z_{12}, z_{21} and z_{22} are the impedance parameters. The input impedance with the output open z_{11}, is defined as the input voltage v_1, divided by the input current i_1, with the output current i_2, equal to a constant or zero. A shorthand notation for this definition is

$$z_{11} = \left(\frac{v_1}{i_1} \right) i_2$$

Similarly, the other parameters may be defined as follows

$$z_{12} = \left(\frac{v_1}{i_2} \right) i_1, \quad z_{21} = \left(\frac{v_2}{i_1} \right) i_2, \quad z_{22} = \left(\frac{v_2}{i_2} \right) i_1$$

(Please turn to page 38.)

HIGHWAY PATTERNS

By Roger Algee B.C.E. '57

Cartoons by George Hinshelwood B.M.E. '57

There are two basic types of highway patterns. These patterns differ from each other greatly in over-all appearance.

A point pattern occurs when roads are built directly toward cities wherever these cities happen to be. This results in a system of roads running in all directions and the roads turn according to the direction of the next nearest city.

The geometric pattern is a consistent highway network, preferably North-South and East-West, fitted to the landform upon which it rests and to the geography by which it is contained. The geometric pattern appears somewhat like lines of longitude and latitude on a globe. But geometric highways do not necessarily run in straight lines. They often have curves and turns to accommodate the landforms just as do the point highways. Instead of running directly toward points of public interest, geometric highways reach these points by using a consistent set of uniformly parallel directions. However, geometric patterns should be bounded by curving ocean drives and occasionally cut through by scenic mountain parkways.

The two foregoing patterns for arterial highways also apply to roads and boulevards. But in business and residential areas, it happens that streets and avenues are usually rectangular except on very hilly land where they appear somewhat like contours on a physical map. Unfortunately, a modernistic pattern has appeared in certain housing projects. These projects have curving avenues that make it very difficult to find a house by its address.

The point system has highways running from city to city and in all directions. The geometric system has highways running mostly North-South and East-West, nearly parallel, and about evenly spaced.

Traffic Surveys

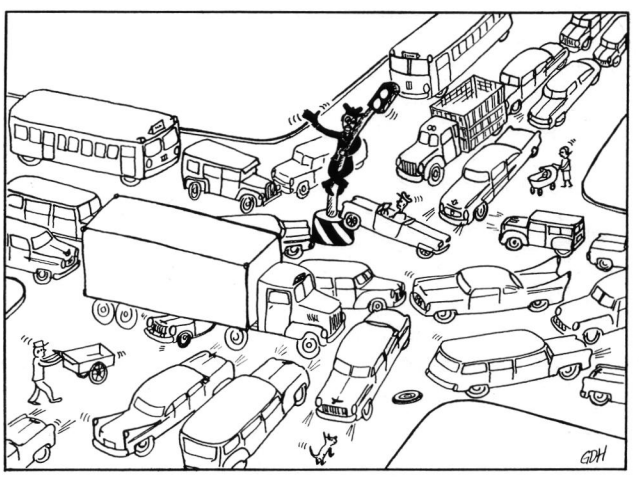
In planning new highways, inventories are taken of traffic and existing highways. By comparing needs with available facilities, the decision is reached as to where to build or improve the highway system.

In cities having point boulevards, it is necessary to make wide house-to-house destination surveys to find out where people want to go. The assumption that the most heavily travelled boulevards are the most desired routes has proved to be false. Many people take a given boulevard because it is favorably signaled or because it is well known, even though it may be a round-about route. These destination surveys are expensive and their interpretation tedious.

With boulevards constructed on geometric principles, the necessity for destination surveys is eliminated because traffic naturally takes the shortest route to its destination. This condition occurs because geometric highways are apt to be signaled with equal favor and their direction understood. With traffic heading for destinations by the most direct route, overcrowding of itself indicates where improvement is needed. Such overcrowding is easily determined by airphotos or by conference with the police. Airphotos taken at intervals throughout the day and night could give a complete picture of the location of traffic. The police, however, are usually aware of the location of those intersections creating traffic jams.

In the point system a highway route is selected which connects two cities with the highway of least cost. Such a selection presumes that the need is to connect a given pair of cities with a highway. This assumption, however, is the basic fallacy of planning from which all future design and construction is likely to proceed. It is desirable to consider all the uses to which a highway route may be put as well as its reaction with the entire highway system.

It almost never happens that highways are used to an overwhelming degree for the purpose for which they were originally conceived. Invariably, changes occur which create new traffic destinations. Hence, the high-



The police are aware of the location of those intersections creating traffic jams.

way route, being a rather permanent feature, had best be selected for universal uses. Also, few highways are built which sooner or later are not intersected by other highways. Thus, a route should be selected which is least likely to create interference with traffic on other highways, present or future.

In the point system, the location of future highways can not be predicted. But under the geometric system, future highways can be anticipated as further steps in an already orderly development.

It is true without a doubt that conventional selection of the most direct route from one city to another is the cheapest route for that one highway. But for the system as a whole, a pattern resulting from such selections requires more highway length in order to have highways closest to all possible points in the area. This condition occurs because the point system creates unbalanced concentrations of highways at points not evenly scattered over an area. Therefore, the point system is the most expensive for the development of a given area.

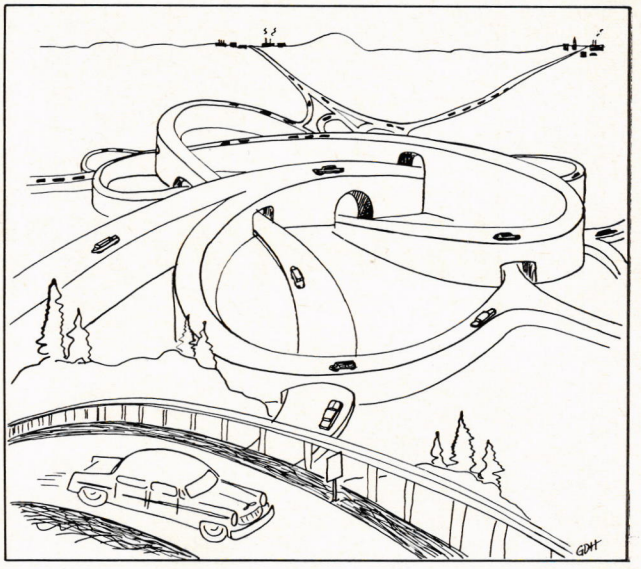
In establishing freeways, the greatest cost is the purchase of valuable land for the small portions of the right-of-way within the cities. The solution to this problem is not merely to by-pass cities, but rather to miss them altogether, as if they were not there. The *width* of a portion of freeway should vary with the amount of traffic from nearby cities, but the *route* of a freeway should be independent of the location of cities.

The greatest deterent to motoring and trucking with beneficial effects on the general prosperity is city congestion. By locating freeways outside cities slowing of continental traffic will be eliminated. Inter-city travel can also be greatly expedited because travel time is not so much a matter of distance as it is a matter of traffic. The city dweller himself receives greater safety at less cost from wide boulevards than from high speed freeways. Freeways should avoid cities entirely since cities must contain slowly moving traffic masses.

Under the point system, highways tend to pass through cities because, by definition, that is their object. But with a geometric system, it is likely that a freeway will miss most cities because geometric freeways would be spread evenly over a continent of which the cities can occupy only a small part.

With a point pattern, highways run in every direction and hence cross at all angles with any number of highways meeting at or near a common point. Often, elaborate structures must be established to carry a large number of vehicles through a small area. Such a condition requires that traffic surveys determine the number and destination of vehicles, that ingenious turns and connections be designed, and that each intersection be custom built. The resulting maze causes drivers to miss proper turns and be shunted off their planned routes for many exasperating miles. Important details are always omitted on general maps making it impossible to safely plan travel routes through these complex intersections.

But with the geometric system, exactly the opposite is true. Intersections should always be of the simple two-highway, right-angle type. Freeways having a standard cloverleaf grade separation are sufficient to provide a consistent and understandable means of changing directions of continental travel. Boulevards can handle any amount of mass traffic at one-level intersections if there is sufficient highway area in the city to handle the whole traffic. Prolonged waits for many streams of traffic are avoided because of the presence of a maximum of two highways at each intersection. One-level intersections on country roads are likewise able to handle anything the road can produce if adequate storage capacity is provided at the intersections. It is an undeniable truism that the traffic on country or suburban roads clogged with weekend traffic is limited by the intersections and not by the main trunk of the road. The area of road surface required for turn lanes and intersection storage is much less than the area required on the main trunk. The economical way to handle weekend traffic on country roads is through establishment of wide intersections. By locating roads geometrically, intersections can be placed near to, but outside of, local congestion.



With a point pattern, highways run in every direction.

In any system of directional signs, consistency is the most important feature because no matter how large the sign, there will not be sufficient time for interpretation unless the driver already has a preconceived notion of what he is looking for. With the point system, no consistent group of directional signs can be developed because these highways lead in all directions and have unpredictable major turns, especially at intersections. This results in the placing of a large mass of signs which tends to create even greater confusion because it becomes more difficult to select those signs which are useful to the driver concerned.

With the point system, individual traffic counts are necessary in order to custom design a complex control system for the traffic lights in each area. Not only are such signals forbiddingly expensive, but also they can never keep traffic flowing without stops because the distances between intersections vary according to no systematic rule.

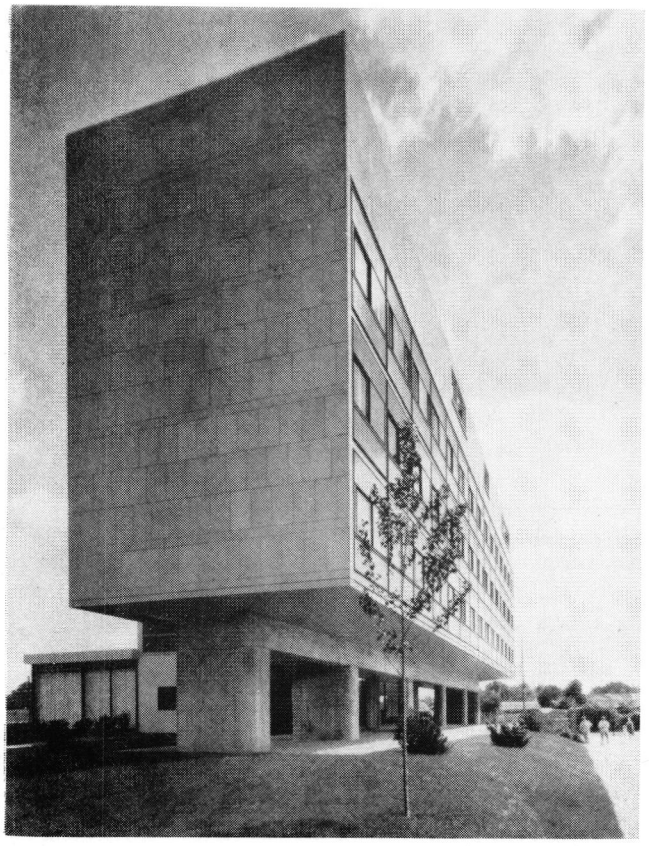
(Please turn to page 28.)

A CITY FOR THE FUTURE

By Albert Pinto B.E.E. '57

They are building a town in Chandigarh, India, which is to be the capital of the state of Punjab. When erected it will be an example of the ideal city, adapted to our present need for modernization. The task of building it has been given to the Swiss-born, French architect Le Corbusier. In this city for 150,000 people, Le Corbusier tries to apply the principles and ideas he has advocated since 1910. Life has been a struggle for this great architect; his attempts to present his ideals to humanity have met with little success. His architecture has two goals: a functional one and a humanitarian one, and yet he has been criticized by such an authority as Frank Lloyd Wright. The construction of Chandigarh gives him the opportunity to apply his concepts, and to achieve his two goals in city planning and in the building itself.

For the functional purpose of the town, a distinction is made between the business district, the dwelling area, and the industrial area. The business district is located at one end of the city, for example in the north. The special atmospheric, climatic, geographic and geological conditions, are studied in each case. The buildings in the business area are bigger than the New York skyscrapers and spaced much farther apart. The New York buildings are much too small and overcrowded. In Wall Street, for instance, not much sun is received by the office buildings. In other parts of the city the narrow streets prevent the unwholesome air from ascending, and the street noises reflect from wall to wall. To achieve the density of 1,200 people per acre in the business center, the ideal height of a "superskyscraper" is one thousand feet or sixty stories, "a dimension that seems to me good," according to Le Corbusier.



The Swiss Pavilion at the Cite Universitaire, Paris, France. ***Photo courtesy the French Embassy, N. Y.***

The dwelling area is located at a minimum distance from the business area and yet far enough from it so that the inhabitants can enjoy sun and verdure. "The essence of the city is the dwelling area," therefore it occupies the most central location with a possibility for future expansion toward the open country. For this expansion, a spiral pattern of the living area is convenient because a group of first ones can be erected in the center and others can be constructed around it, as necessary. The buildings in the dwelling area are of the "Radiant City" type, of less altitude than the business center but measuring about 160 feet tall and yielding a density of about 120 inhabitants per acre. Building high in the living quarters liberates more ground and space, space that can be utilized for gardens and trees: "the ground is an uninterrupted park given to pedestrian traffic."

The industrial area is located at the other end of the town and includes plants, warehouses, heavy and light industries. Situated in this way it permits the dwelling center to be in between the business and industrial areas. A family may include a member working in an office and a member working in a factory who have identical daily schedules: one goes to one wing of the city, the other to the opposite, but because of the central location of their home they leave and return at the same time, and harmony is brought into the family. "The industrial sector should be independent of the living quarters and separated from each other by verdant zones."

In planning a city, Le Corbusier sets an orderly pattern. Each center enjoys a special location, and the sum of these centers constitutes the town. The single unit is more important to Le Corbusier than city-planning as a whole, and consequently, he devotes greater study to this topic. As said before, the building occupies the very center of the block, and since the density of population increases as a result of increased height, more ground space is liberated for the use of the pedestrian. This liberated area must be a garden spot and, in this manner, "Nature is entered in the lease."

The area occupied by the building itself is even reduced to a minimum by suspending it above the ground on supporting stilts. Stilts, "the key to the problem of circulation posed by great cities" (to quote Professor Maurin of the Faculty of Science in Paris, 1933), are essential to the liberation of the ground so that the pedestrian faces fewer obstacles to his sight and can at the same time use the space between ground and building for traffic. An English architect, Mr. John Ratcliff, criticizes the use of supporting "pilotis" (stilts) in the "Unite d'Habitation" of Marseille when he mentions that the plane of the ground in this particular building does not "float through the building."

Mr. Blake, curator of the New York Museum of Modern Art, gives him an answer:

> *. . . on the southwestern edge of Marseille, the French government is setting up a colossal experiment in housing which Le Corbusier, at the age of 62, is willing to accept as a test of all his theorizing about the design for living in the modern world.*

Since the building is set up on stilts, it is no longer an obstacle. Motorists will pass beneath the unit, go through it or can enjoy the green perspectives of the park. The building is now aloft and the area underneath it can serve as a shelter for the hot days of the summer.

The condition to setting roads through the building is that it should be tall and massive. Although one can build a street through a small building, the arrangement would appear awkward. Building in height brings happiness to the dweller because "now with the play of clouds and now of stars, here the spread of ground, unbroken horizons, and the ranges of tall, handsome trees," he has a sensation of dominating the ground.

Great improvements have been made in architecture by the use of rust-proof steel and reinforced concrete, and Le Corbusier advocates their wider use. Their workability permits greater versatility in design so that the building can be made not only functional but also æsthetic.

Sun is the governor. The disposition of the building and that of the walls are studied accordingly. Glass walls give to the facade a lighter aspect and absorb more light and sun. However, when the sun is too strong, sun breakers are mounted on the glazed walls to keep out the excess heat. For this reason, the south facade is equipped with sun-breakers. These small canopies consist of a prolongation of the slab in each floor and allow the low lying sun of the winter, the morning and the evening, to enter the dwelling. The high sun of summer and of noon is broken before its rays reach the protected windows. On the contrary, the north facade is not equipped with sun-breakers because it receives very little

View of the "Radiant City" in Marseilles, France.
Photo Favatier, Viollet

light. Glass is a remedy to the misuse of wall "holes." These holes are abusively utilized for canalizing odors and light. They consist of doors and windows. They destroy form in the beauty of the design. Glass in an extensive use restores its artistic shape.

Some people have complained about glass walls. A resident of the Swiss Pavilion at the Paris Cite Universitaire, which Le Corbusier constructed in 1936, says that students "find that the glass wall facing south in their rooms means they freeze in winter and stifle in summer." But, reading these words, one finds that the theory has not been correctly applied. The glass walls should have faced north and sun-breakers should have been used in the south facade. The Swiss Pavilion is only a tentative experiment of the thirties and the architect should not be blamed for an early defect. Le Corbusier's theory has improved since and "l'Unite d'Habitation" of Marseilles represents a step further in his improvement. Had he been listened to before and his theories applied earlier, misconceptions would have been avoided.

The top floor of the building is partly devoted to the health service of the community and includes a garden terrace. The health service consists of prenatal clinics, creches, nurseries, kindergartens, and has rooms for physical exercises during the winter. These are indispensable for the care of the children, the games of the young and for the sports of the adult. In the summer time part of these activities are transferred to a garden terrace which has space for small trees, leaves and flowers.

The Radiant City is the city of today and its pattern should be utilized by the young architect in the service of progress and humanity. "It will stand as a prototype at the crossroads of the new architecture; as the efficient way of life for people in a machine civilizaiton; as the fundamental reform for modern urbanism."

OMAR KHAYYAM
The Poet — Scientist

By Mohammed - Bashir Ludin B.C.E. '57

For most people it may be a new thing to know that Omar Khayyam, the poet who wrote the *Rubaiyat*, was also a mathematician and astronomer. His personality as a scientist, however, is overshadowed by the popularity of his poems. We cannot say, though, that the world has not at all recognized him as a scientist. In the history of science he is known as a post-mathematician; as for example, Bertrand Russell says, "Omar Khayyam, the only man known to me who was both a poet and mathematician, reformed the calendar in 1079." If we consider Mr. Russell's knowledge of the history of science as being quite an extensive one, we may permit ourselves to believe that Omar Khayyam may be the only poet-mathematician mentioned in the history of science. The question of whether Khayyam may or may not be the only poet-mathematician, however, is not the main concern of this paper. It is the purpose of this essay to evaluate his contributions to science in general and to mathematics and astronomy in particular.

But, before discussing his scientific works, a biographical sketch of Khayyam might help us know him better as a scientist. His full name is Omar B. Ibrahim al-Khayyam, and Khayyam is his poetic name which means the "tent-maker." It is said that Omar Khayyam once practiced the trade of tent-making, and perhaps due to his liking for this profession he chose "Khayyam" as his poetic name. Khayyam himself alludes to his name in the following lines:

"Khayyam, who stitched the tents of science,
Has fallen in grief's furnace
and been suddenly burned;
The Shears of Fate have
cut the tent ropes of his life,
And the broker of Hope
has sold him for nothing!"

Khayyam was born in Naishapur, Khorassan, in the latter half of the eleventh century and died within the first quarter of the twelfth century. Nizam ul Mulk, Vizier to Alp Arslan, in his *Wasiyat*—or Testament—which he wrote and left for future statesmen says that he himself, Omar Khayyam, and Hasan Ben Sabbah were the three students of Imam Mowaffak of Naishapur, "one of the greatest wise men of Naishapur." Nizam ul Mulk adds that the three of them had made a vow, "that to whomever a fortune falls, he shall share it equally with the rest, and reserve no pre-eminence for himself." When Nizam ul Mulk became the Vizier, Hasan Ben Sabbah demanded a position in the government, and his request was granted. Omar Khayyam also came to claim his share of Nizam ul Mulk's fortune, but he did not ask for any title or office.

According to Nizam ul Mulk, Khayyam made his demand in these words, "The greatest boon you can confer on me is to let me live in a corner under the shadow of your fortune, to spread wide the advantages of science." Nizam ul Mulk concludes his account of Khayyam in the following words:

> *"At Naishapur thus lived and died Omar Khayyam, busied in winning knowledge of every kind, and especially in astronomy, wherein he attained to a very high pre-eminence. Under the Sultanate of Malik, he came to Merv, and obtained great praise for his proficiency in science, and the Sultan showered favors upon him."*

Nizami of Samarcand, who was one of Khayyam's pupils, relates the following story about his teacher, Khayyam:

> *"I often used to hold conversation with my teacher Omar Khayyam, in a garden, and one day he said to me, "My tomb shall be in a spot where the north wind may scatter roses over it." I wondered at the words he spake, but I knew that his were no idle words. Years after, when I chanced to revisit Naishapur, I went to his final resting-place, and lo! it was just outside a garden, and trees laden with fruit stretched their boughs over the garden wall, and dropped their flowers upon his tomb, so that the stone was hidden under them."*

Omar Khayyam's contributions to science are constituted of his works on algebra and astronomy. With regard to his algebra Sir Thomas Arnold says that it "marks a stage in the advance of this branch of mathematics," and comparing Khayyam's book on algebra with Greek Algebra, Sir Arnold gives the following evaluation:

> *"A book of the first rank and one which represents a much more advanced state of this science than we see in Greeks."*

From this evaluation of Sir Thomas Arnold we see that Khayyam pushed ahead the frontiers of algebra relative to Greek works. However, we know that Islamic

mathematicians who preceded Khayyam also have done a great deal for the advancement of this science. Let us then, compare Khayyam's work with those of Khayyam's Moslem predecessors. In comparing Khayyam's algebra with that of Alkhwarizmi, Sir Thomas Arnold says, "Omar also marks a considerable advance on Alkhwarizmi." This statement is justified by regarding the degree of equations involved in the works of these two mathematicians. The greater part of Khayyam's work is actually devoted to cubic equations, while Alkhwarizmi dealt only with quadratics.

Although cubic equations signify the advanced nature of Khayyam's mathematical work, attempts were also made by Greeks and numerous Arab mathematicians to solve problems involving such equations. According to some historians of science, "the foundations of cubic equations had been laid by the Greeks, for it was Menæchmus who first constructed the roots $X^3—2a^3=O$." Among the Arab predecessors of Khayyam who have attempted to solve cubic equations were Almahani of Baghdad, Abu Gafar Alhazin, Alkuhi, Alhasan ben Alhaitan and others. Of these mathematicians, the first to state a problem of cubic equation was Alhmahani, and the first one to solve cubic equations by conic sections was Abu Gafar Alhazin. Attempts were also made to determine the side of a regular heptagon, which required the construction of the side from equation $(x^3—x^2—2x+1=O)$. This problem was finally solved by Abdul Gud.

It might be interesting to the reader to see the explanation given by Khayyam about the attempts made by others concerning cubic equations and, in particular, the problems that he himself dealt with. At the beginning of his treatise on Algebra, Khayyam says:

> *"In this study we meet with propositions depending on certain very difficult kinds of preliminary theorems, in the solution of which most of those who have tried have failed. No work of the ancients dealing with them has come down to us."*

This comment of Khayyam indicates that he believed in the originality of his work. Originality of his work may or may not be important in the history of science and mathematics. The thing which is really important is his rather extensive treatment of cubic equations. He classifies cubic equations into twenty-seven classes, again divided into four categories. The last two of the four categories consist of trinominal and quadrinominal equations, that is, equations composed of three terms and four terms, respectively. The fourth category, for example, contains the three classes

$$(1)\quad X^3 + BX^2 = CX + D$$
$$(2)\quad X^3 + CX = BX^2 + D$$
$$(3)\quad X^3 + D = BX^2 + CX$$

In solving such equations Khayyam used geometrical construction and analysis — by "a kind of analytic geometry as it was conceived before Descartes at a period when the systems of coordinates and mathematical notations were not yet established." He believed that cubics could not be solved by calculation, and he rejected negative roots and often failed to find all the positive roots of an equation.

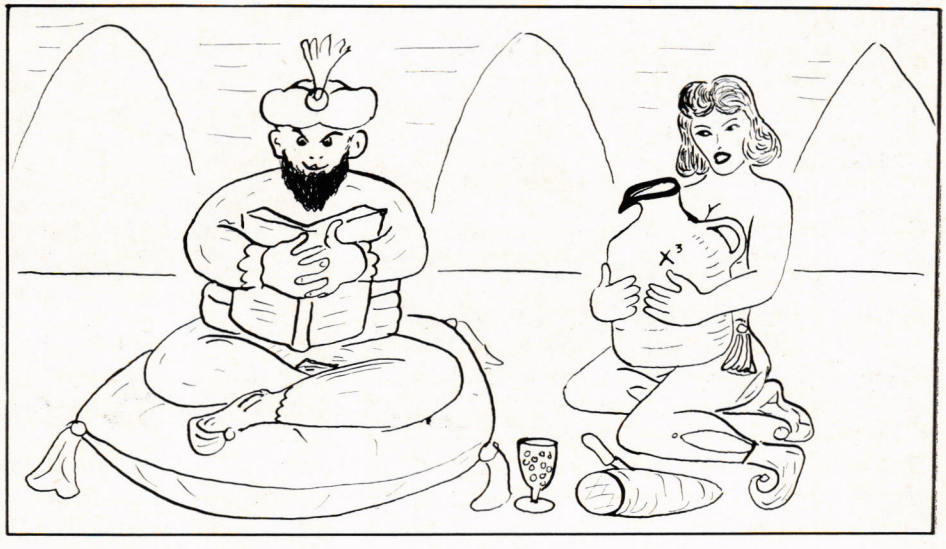
The fact that Khayyam used geometrical construction makes his method similar to that of Alkhwarizmi. The aims of these two Moslem scientists in the solution of equations were very different from those of the Greeks. Let us consider Menæchmus' method as the representative of the Greek method. It was not the aim of Menæchmus to find the value of (x) in a given cubic equation but simply to determine the side (x) of a cube double another cube of a side (a). On the other hand, the problems with which Khayyam and Alkhwarizmi dealt were not problems of geometry as such. Khayyam and Alkhwarizmi used geometry as a tool to solve the problems which were essentially mathematical.

As we mentioned above, Khayyam's scientific works covered astronomy, too. In the following lines he may have referred to his reform of the old Persian calendar.

> *'Ah, but my computations, people say*
> *Have squared the Year to Human Compass, eh?*
> *If so, by striking from the calendar*
> *Unborn tomorrow, and dead yesterday."*

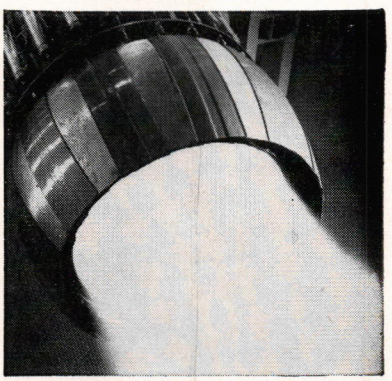
When the Malik Shah determined to reform the calendar, Omar was one of the eight learned men employed to do it; the result was the Jalali era. This calendar had an error of one day in five-thousand years while the present Gregorian calendar has an error of one day in 3330 years.

In conclusion, we may say that Khayyam's achievement in algebra "marks a stage" in the development of mathematics, and that Khayyam was not only a poet but a devoted scientist as well.



A loaf of bread
A jug of wine
And — algebra

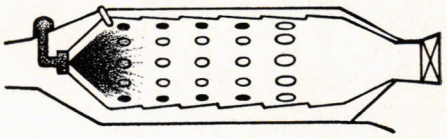
What's doing...



One indication of accomplishment in the combustion field: the J-57 engine, augmented by afterburner, provided the thrust which made supersonic flight practical for the first time.

This special periscope gives Pratt & Whitney Aircraft engineer a close-up view of combustion process actually taking place within the afterburner of an advanced jet engine on test. What the engineer observes is simultaneously recorded by a high-speed motion picture camera.

at Pratt & Whitney Aircraft in the field of Combustion*



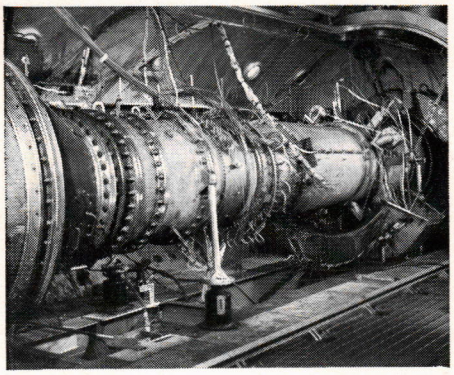
Historically, the process of combustion has excited man's insatiable hunger for knowledge. Since his most primitive attempts to make use of this phenomenon, he has found tremendous fascination in its potentials.

Perhaps at no time in history has that fascination been greater than it is today with respect to the use of combustion principles in the modern aircraft engine.

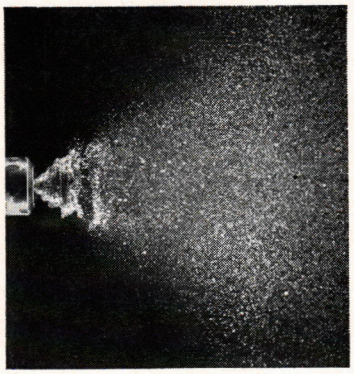
At Pratt & Whitney Aircraft, theorems of many sciences are being applied to the design and development of high heat release rate devices. In spite of the apparent simplicity of a combustion system, the bringing together of fuel and air in proper proportions, the ignition of the mixture, and the rapid mixing of burned and unburned gases involves a most complex series of interrelated events — events ocurring simultaneously in time and space.

Although the combustion engineer draws on many fields of science (including thermodynamics, aerodynamics, fluid mechanics, heat transfer, applied mechanics, metallurgy and chemistry), the design of combustion systems has not yet been reduced to really scientific principles. Therefore, the highly successful performance of engines like the J-57, J-75 and others stands as a tribute to the vision, imagination and pioneering efforts of those at Pratt & Whitney Aircraft engaged in combustion work.

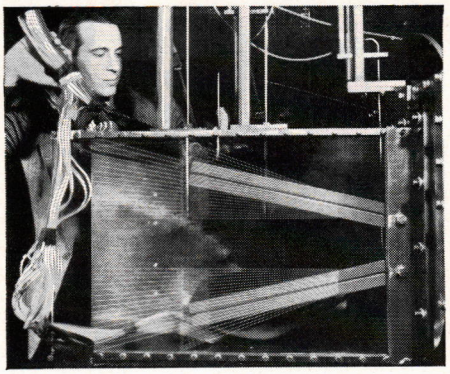
While combustion assignments, themselves, involve a diversity of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program—with other far-reaching activities in the fields of instrumentation, materials problems, mechanical design and aerodynamics — spells out a gratifying future for many of today's engineering students.



Mounting an afterburner in a special high-altitude test chamber in P&WA's Willgoos Turbine Laboratory permits study of a variety of combustion problems which may be encountered during later development stages.



Microflash photo illustrates one continuing problem: design and development of fuel injection systems which properly atomize and distribute under all flight conditions.



Pratt & Whitney Aircraft engineer manipulates probe in exit of two-dimensional research diffuser. Diffuser design for advanced power plants is one of many air flow problems that exist in combustion work.

Watch for campus availability of P & W A color strip film on combustion.

World's foremost designer and builder of aircraft engines

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

EAST HARTFORD 8, CONNECTICUT

OUT OF THE BRIEFCASE

"VULCAN" GUN

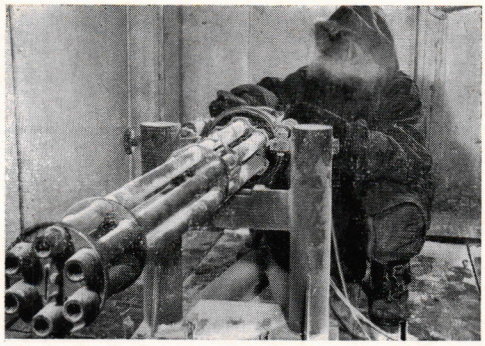
A rapid-firing 20-millimeter weapon, specifically designed for supersonic jet aircraft, was recently unveiled at the Aberdeen Proving Grounds.

Named after Vulcan, ancient Roman God of fire, the new weapon was developed by General Electric, sponsored by the U.S. Army Ordnance, with technical supervision from the Springfield, Mass. Armory. Development of the new 20-millimeter cannon was prompted by the tremendous increase in speed of modern jets. The Vulcan fulfills the requirement of a weapon capable of firing at an extraordinarily high rate in the short time available to shoot at fast moving targets.

The Vulcan has "borrowed" two design features from the original Gatling gun, patented in 1862. Both guns have a rotating multi-barreled cluster, and both are externally driven. The Vulcan gun is externally powered by either electricity or hydraulic fluid.

Engineers made a study of every machine gun mechanism patented in the United States. The Gatling design was selected because its rotating cluster of barrels offered the necessary characteristics for an extremely high rate of fire. According to its designers, the Vulcan gun is simple to operate and maintain, and can be field stripped and reassembled in less than 30 minutes.

In addition to having a high firepower to weight ratio, Air Force tests have proven that the Vulcan Gun operates satisfactorily at temperatures as low as—67 degrees F, and can also use standard lubricants in existence today. Further tests have revealed that the Vulcan is extremely reliable and the life of the gun is satisfactory for the most exacting operational uses.



Vulcan Gun in Cold Chamber

OPPOSED PISTON ENGINE

The greatest possibility for reducing the size and weight of diesel engines for marine and rail uses is offered by a highly supercharged two-cylinder engine compounded with a turbine driving an axial flow compressor. The cylinder layout which offers the greatest potentiality for such development is the "opposed piston" design.

An interesting solution of the problem, the Napier "Deltic" engine, has opposed piston cylinders arranged in a triangle with crank shafts at the three corners. This arrangement overcomes most of the technical objections to the opposed piston layout. Furthermore, the space in the center of the delta may be used for an axial flow compressor, making the complete compound engine compact. This engine weighs about 2½ lb. per BHP for an output of 550 BHP.

Apart from space and weight savings which are important in ships and locomotives, a reduction in overall maintenance costs was reported to be derived from the use of small engines. A complete change of engines is possible within a few hours.

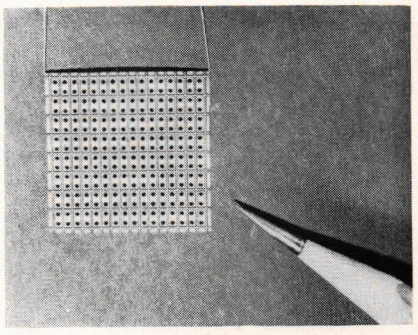
ELECTRONIC MEMORY UNIT

A new memory device that will enable electronic computers to store more than a million bits of information in a space little larger than a shoe box and to recall any or all of the items in a few millionths of a second was announced recently by the Radio Corp. of America.

The new unit consists basically of thin, printed plates of special magnetic material perforated with small holes and was developed under the direction of Dr. J. A. Rajchman, who also developed a magnetic core system used in many present-day computers.

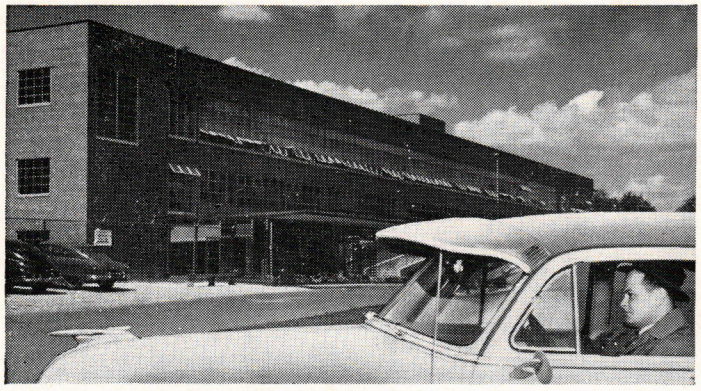
Explaining the new device, Dr. Rajchman pointed out that its operating principles, like those of the magnetic core system, are based on the fact that computer language consists only of "O" and "l" used in various combinations to represent any words, numbers or symbols. Since any desired information can be formulated in terms of "O" and "l" it is possible to employ a storage or memory system in which each of the memory elements can be switched electrically to represent one or the other of these two values. The new aperture plate memory stores this information in the form of magnetic fields. One of the two values is represented by a magnetic flux in one direction around a hole in the plate, while the other value is represented by a magnetic flux in the opposite direction.

(Please turn to page 26.)

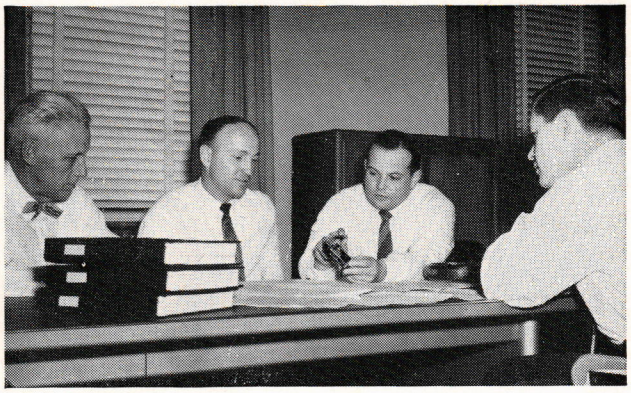


Meet Dick Foster

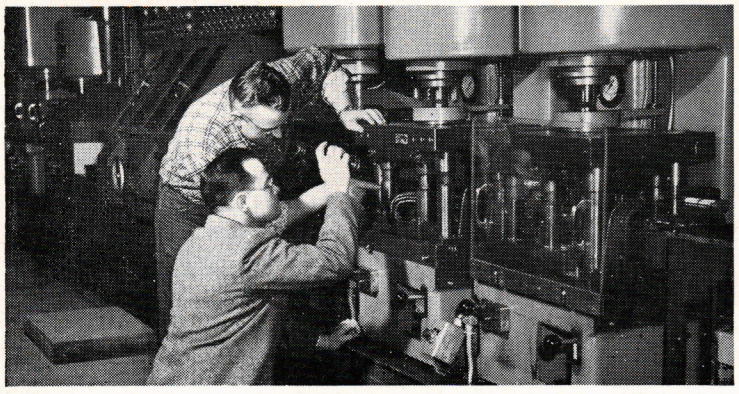
Western Electric development engineer



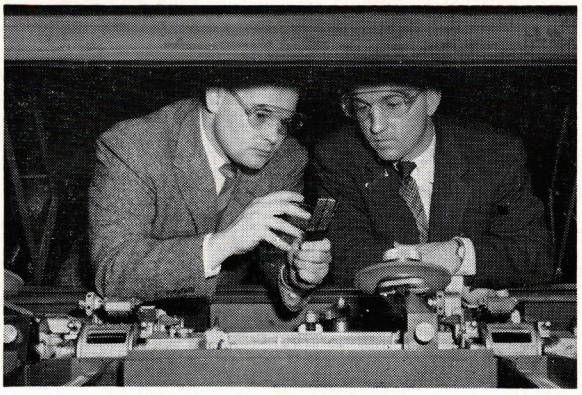
Dick Foster joined Western Electric, *the manufacturing and supply unit of the Bell System, in February 1952, shortly after earning his B. S. in mechanical engineering at the University of Illinois. As a development engineer on a new automation process Dick first worked at the Hawthorne Works in Chicago. Later, he moved to the Montgomery plant at Aurora, Illinois where he is pictured above driving into the parking area.*



Dick's day may begin *in one of several ways: an informal office chat with his boss, a department "brain session" to tackle a particularly tough engineering problem (above); working with skilled machine builders in the mechanical development laboratory; or "on the line" (below) where he checks performance and quality and looks for new ways to do things.*



Here Dick and a set-up man check over *the automatic production line used to manufacture a wire spring relay part for complex telephone switching equipment. This automatic line carries a component of the relay on a reciprocating conveyor through as many as nine different and very precise operations—such as percussive welding in which small block contacts of palladium are attached to the tips of wires to within a tolerance of ± .002".*



Examining the plastic molded "comb" *components of the wire spring relay Dick recalls his early work when he was involved in working-up forming and coining tools for the pilot model of the automation line for fabrication of wire spring sub-assemblies for relays. At present he is associated with the expansion of these automation lines at the Montgomery Plant.*

Dick finds time *for many Western Electric employee activities. Here he is scoring up a spare while tuning up for the engineers' bowling league. He is active also in the golf club, camera club, and a professional engineering society. Dick, an Army veteran, keeps bachelor quarters in suburban Chicago where he is able to enjoy the outdoor life as well as the advantages of the city.*

Western Electric offers a variety of interesting and important career opportunities for engineers in all fields of specialization in both our day-to-day job as the manufacturing and supply unit of the Bell System and in our Armed Forces job.

If you'd like to know more about us, we'll be glad to send you a copy of "Your Opportunity at Western Electric" which outlines the Company operations and specific job opportunities in detail. Write: College Relations Department, Room 1030, Western Electric Co., 195 Broadway, New York 7, N. Y.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; Haverhill and Lawrence, Mass.; Lincoln, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 29 cities and Installation headquarters in 16 cities. Company headquarters, 195 Broadway, New York City.

(Continued from page 24.)

The small plates used in the new system are made of a special ferromagnetic, ceramic-like, material that can be molded in any desired size or shape, and hardened by heating. The experimental units produced are less than an inch square and contain 256 holes, permitting the storage of 256 bits of information in each plate. The plates themselves are insulators and the holes can be joined by conductors using the highly efficient printed circuit technique in place of the complex storage and readout windings of the previous core system.

The development of these aperture plates makes possible memories of very large capacity, simpler circuits and very compact units of small capacity. Dr. Rajchman displayed a compact memory plate unit consisting of ten plate assemblies and a novel switch also made from the plates. This development unit, measuring only 2 cubic inches, has a storage capacity of 2560 bits of information.

URANIUM TAPE

Five miles of plastic tape laden with enriched uranium will be used in experiments to help determine the reactor design for one of the nation's first nuclear power plants, The Babcock & Wilcox Company revealed at the opening of the Atomic Industrial Forum's annual conference.

Enriched uranium 235 will fuel an experimental reactor being assembled at Lynchburg, Virginia, the first such facility in the country built by private industry. Fuel elements for the test reactor will contain the uranium-diffused plastic tape, sandwiched between thorium "converter" plates. This will be the first time that thorium has been utilized in a reactor.

In addition to providing a dispersal medium for uranium oxide, the tape will constitute an added safety device: in the event of an excessive power rise in the core, gas bubbles will form in the plastic, forcing an automatic shutdown of the nuclear reaction.

NUCLEAR SHELL STRESSES

Scientists at the Westinghouse Research Lab have found a way to see and study the complicated stresses existing deep inside the solid steel pressure vessel of a power-producing nuclear rector. The technique uses a model made of special plastic to make visible the stresses in a full-scale pressure vessel—a steel structure housing the core of the reactor.

An exact model of the structure to be studied is constructed from a photoclastic resin, or plastic. Such resins show stresses they undergo when various forces are applied to them. When examined under polarized light, the stresses show up as patterns of colored light.

The plastic pressure vessel model is about two feet high, a foot and a half in diameter, and 100 pounds in weight. After the model is cast, it is machined to exact size. Air is then pumped into the model until it is under a pressure of about four pounds per square inch—a pressure producing exact stress patterns in the actual vessel under its working pressure of 2000 pounds per inch.

The model is cured in heating, which "freezes" the stress patterns permanently into the walls of the model. Samples are then cut from the model and examined under polarized light. The "frozen" stresses can then be studied with great precision.

CANNED PUMPS

Four 1600-hp, 2300-volt "canned" motor pumps—the world's largest—have entered their final stages of construction at Westinghouse's atomic equipment plant. They are the main coolant pumps for the first full-scale atomic electric generating station at Shippingport, Pa.

These are the first canned motor pumps with Class H insulation to be designed for 2300-volt operation. Each pump weighs nearly 14 tons, stands 10 feet high and is 4 feet in diameter. The capacity of each pump is 18,300 gpm at 2000 psi at up to 600 degrees F. There are no external shaft seals in the motor pumps, and suction and discharge nozzles are designed to be welded into the pipeline.

New careers for engineers, now that

Color TV is here!

RCA's pioneering in this exciting medium means unlimited opportunities for you in every phase from laboratory to TV studio

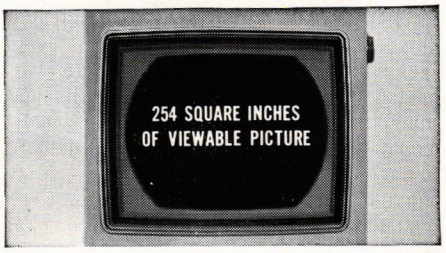
Now, more than ever, new engineering skills and techniques are needed in the television industry — to keep abreast of the tremendous strides being made in Color TV. RCA — world leader in electronics — invites young engineers to investigate these challenging opportunities. Only with RCA will you find a scientific climate particularly suited to the needs of young engineers. Your knowledge and imagination will be given full rein. Rewards are many.

Your talents are needed in research — in TV receiver design — in network operations — even "backstage" at TV studios. The experience and knowledge you gain can take you anywhere!

WHERE TO, MR. ENGINEER?

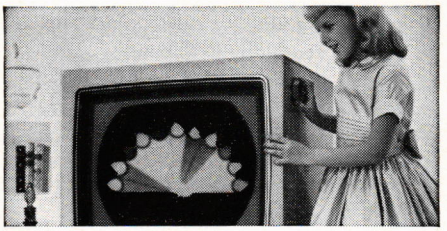
RCA offers careers in TV and allied fields — in research, development, design and manufacturing–for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. Join the RCA family. For full information write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, New Jersey.

Like 2 sets in 1—get Color and black-and-white shows, too! It's RCA Victor Compatible Color TV. See the great Color shows in "Living Color"—regular shows in crisp, clear black-and-white. With Big Color, you see *everything.*

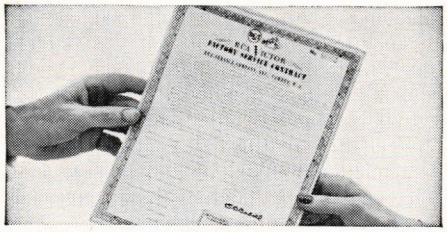


Big-as-life 21-inch picture tube — overall diameter. Actually 254 square inches of viewable picture area. And every inch a masterpiece of "Living Color." Here are the most natural tones you've ever seen—on a big-as-life screen!

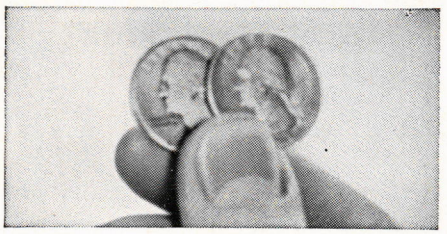
Color every night — right now! Something for everyone! You'll have "two on the aisle" for the best shows ever—drama, comedies, Spectaculars, children's shows, local telecasts. For now 216 TV stations are equipped to telecast Color.



Big Color TV is so easy to tune, even a child can do it! Turn two color knobs and there's your Big Color picture! It's easy, quick, accurate. It's a new thrill when the picture pops onto the screen in glowing "Living Color."

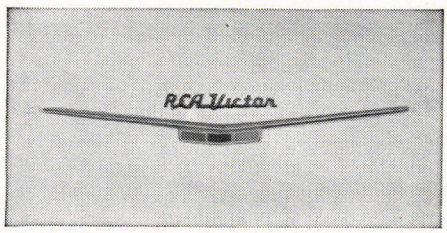


Practical and trouble-free! Service at new low cost! Big Color is *dependable* Color. And RCA Victor Factory Service is available in most areas (but only to RCA Victor owners). $39.95 covers installation and service for ninety days.



Color TV is a common-sense investment—costs only a few cents a day. It's sure to become the standard in home entertainment for years to come—yet you can enjoy Color every night *right now!* And you can buy on easy budget terms.

Now starts at $495 — no more than once paid for black-and-white. This is the lowest price for Big Color TV in RCA Victor history! There are 10 stunning Big Color sets to choose from—table, consolette, lowboys, and consoles, too.



Make sure the Color TV you buy carries this symbol of quality. Because RCA pioneered and developed Compatible Color television, RCA Victor Big Color TV—like RCA Victor black-and-white—is First Choice in TV.

RCA®

RADIO CORPORATION OF AMERICA

ELECTRONICS FOR LIVING

HIGHWAYS

(Continued from page 17.)

However, with the geometric system, highways must be spread at equal intervals in two directions. Thus, it is a simple matter to conceive and execute complete groups of consistent signs such that every sign is immediately useful to drivers trying to locate either themselves or their destinations. Such a group of signs as is made from the 1, 2, 3, . . . A, B, C. . . . method of naming residential avenues is an example.

With the geometric system, the simple progressive method of synchronized signalling can move a car any distance with no stops because the lights are timed to be green when it gets there. This wonderful method of signalling could more than triple the average speed of traffic in most cities. Unfortunately, synchronous signals are not possible over an entire system unless the highways are established at equal intervals such as with the geometric system.

Perhaps the most important effect of selection of a highway pattern is that upon land use. The point system often has several highways meeting at a common point which encourages construction of buildings in one place. Also, traffic is funneled into this central destination because all point highways tend to lead into it. Thus, traffic rushes into the center of the city in the morning and back out in the evening, which creates congestion. This congestion establishes a parking shortage, high delivery cost, and unsafe driving.

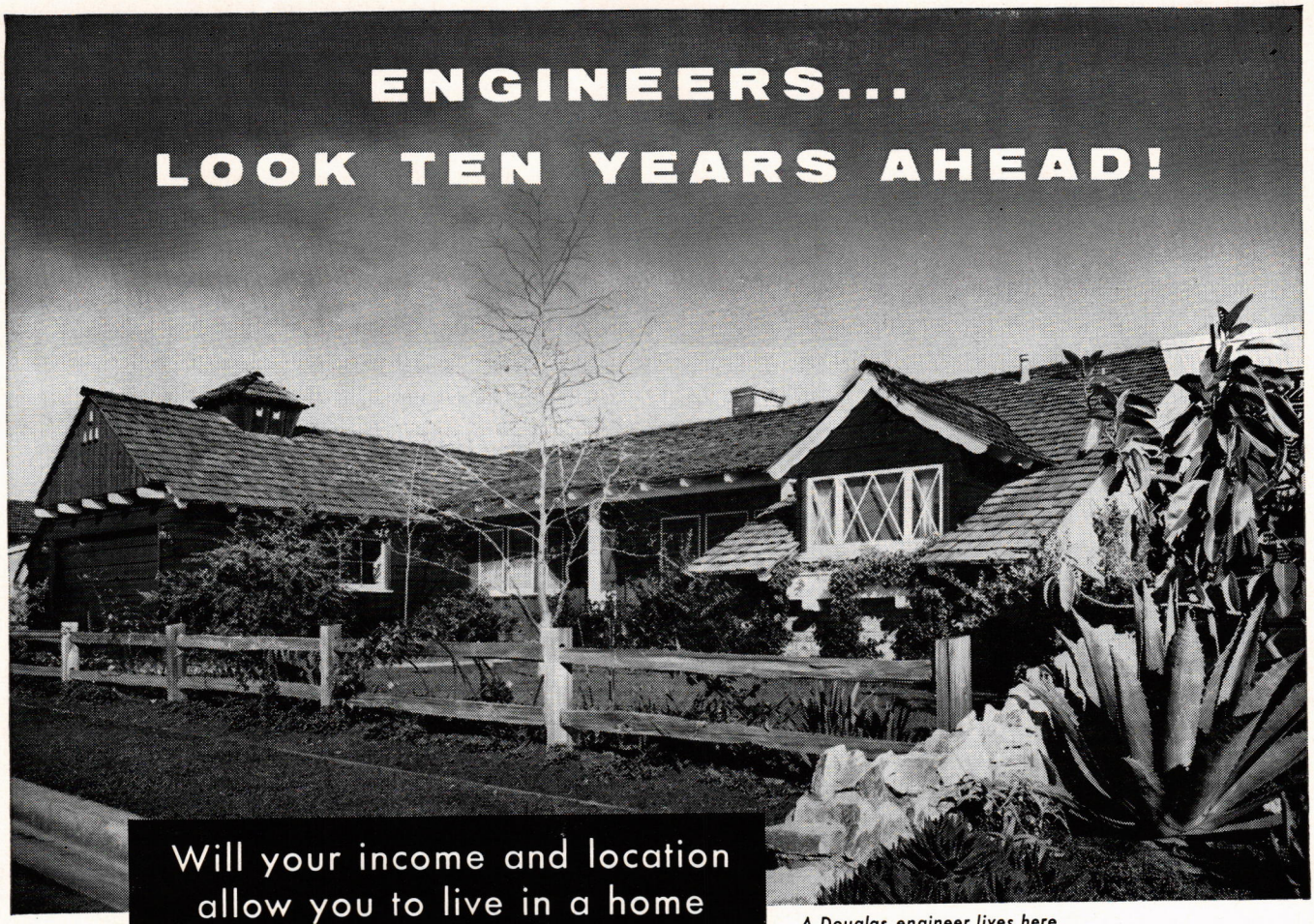
But a fully developed system of geometric highways tends to avoid congestion by directing vehicles equally over the area. However, crowding may easily occur because buildings were made too high in proportion to the highway and parking area. This kind of congestion cannot be avoided by any highway pattern.

In the geometric system there exists a uniform spread of streets equally desirable for trade or production. This allows possible room for free public parking lots. Another feature is that roads can easily be converted to boulevards or freeways. Also, by allowing trucks on every other boulevard, the remaining surface can be constructed at half cost. But such a trucking rule is not possible in the point system because point highways do not run parallel.

By considering the major elements of highway planning, it becomes clear that the geometric system is far better than the point system. Yes, by creating order, we can save dollars, time, and lives.

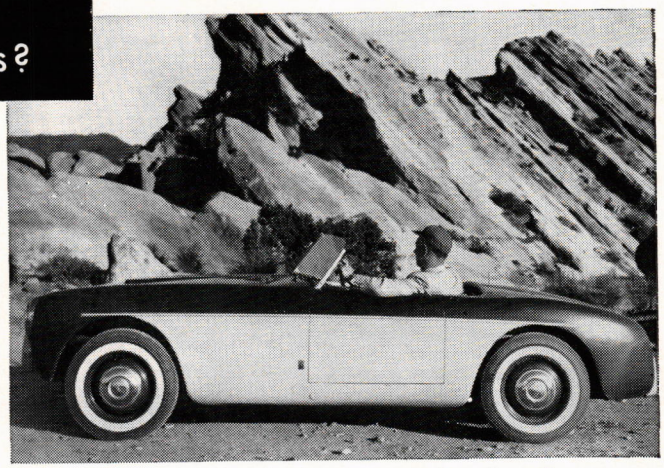
REFERENCE: Howe & Oglesby, *Highway Engineering* (New York, '54), Chp. 3, 6, 7, 10, and 11.

ENGINEERS...
LOOK TEN YEARS AHEAD!



Will your income and location allow you to live in a home like this...spend your leisure time like this?

A Douglas engineer lives here



They can...if you start your Douglas career now!

Douglas has many things to offer the career-minded engineer!

...there's the stimulating daily contacts with men who have designed and built some of the world's finest aircraft and missiles!

...there's enough scope to the Douglas operation so a man can select the kind of work he likes best!

...there's security in the company's $2 Billion backlog of military and commercial contracts!

...and there's every prospect that in 10 years you'll be where you want to be professionally, and you'll be in both the income level and geographical location to enjoy life to its full.

Brochures and employment applications are available at your college placement office.

For further information about opportunities with Douglas in Santa Monica, El Segundo and Long Beach, Calif. and Tulsa, Okla., write today to:

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DOUGLAS

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HEADACHE CORNER

By Sy Mathews B.S.E. '57

Many engineering students find that problem-solving is an interesting pastime. Whether a particular problem is practical or not is of little concern. Obtaining the correct answer to any problem is a thrill in itself, especially if the problem is a real challenge. Here are several problems that may be challenging to you. Let's start off with a few easy ones.

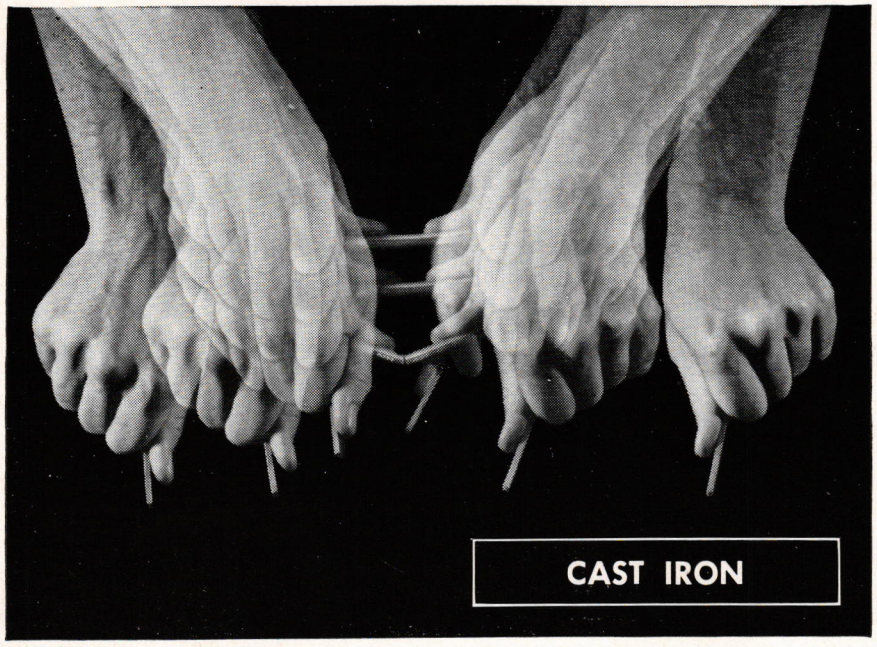
A sphere eight inches in diameter is placed in a hollow cone ten inches in diameter at its base and fifteen inches high. What is the volume of the space enclosed by the surfaces of the cone and sphere? If you find difficulty in solving this one, give it up for the present and attack the next one.

Elmer is 52 years old. He is now thirteen times as old as Matilda was when Elmer was as old as Matilda is now. How old is Matilda? (The number of words in the problem may give you a hint.)

Some problems can be real headaches. If you can do the following one in less than five hours, consider yourself a master. Five men are stranded on a desert island. They have nothing to eat except coconuts. One day they decide to gather all the coconuts they can and divide them equally among themselves. After gathering a large pile of coconuts, they decide to go to bed and divide them the next morning. During the night one of the men, afraid that he will not get his proper share, decides to take his one-fifth of the coconuts. Upon counting the coconuts he finds that one is left over. He, therefore, casts a single coconut away, takes one-fifth of what is left, and goes back to bed. Later, another man does the same thing. He casts an odd coconut away, takes one fifth of what is left, and goes back to bed. One by one all five men go through the same process, each being ignorant of the others' actions. The stinging question is this—what is the minimum number of coconuts that the men could have gathered on the previous day? Your answer may be large.

Here's one that takes clear thinking. A bullet is fired vertically downward from an airplane which is two miles above the surface of the earth. The plane is travelling horizontally at 200 miles per hour. The bullet has an initial velocity of 2000 feet per second. Assuming that the resistance of the air to the motion of the bullet is proportional to the square of the velocity of the bullet, how long will it take for the bullet to reach the earth? Neglect the curvature of the earth's surface.

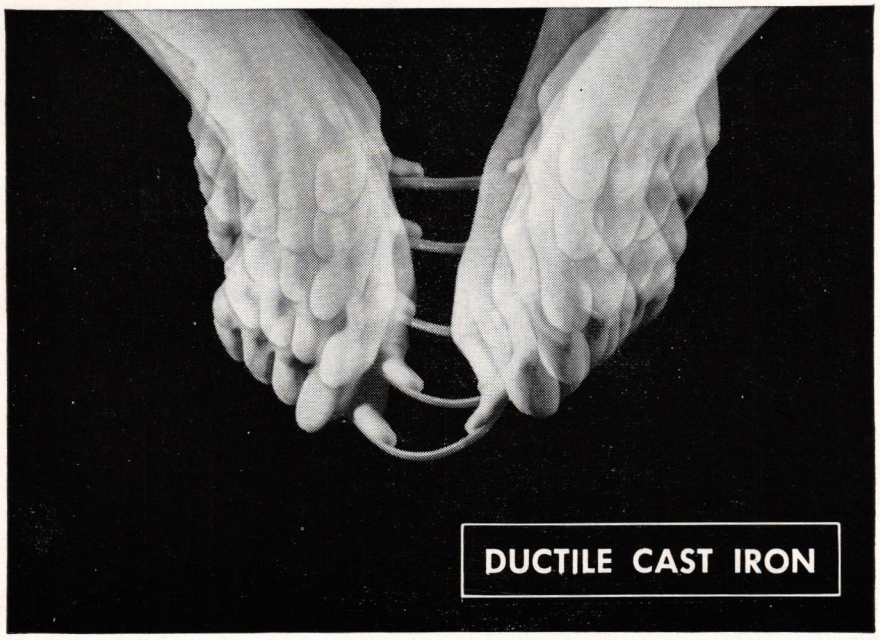
There are no tricks pertaining to the preceding problems. They are completely straight forward. If you feel that your answers are correct, send them to Mecheleciv with a complete explanation as to how they were solved. The first person submitting a set of correct answers to the problems will receive credit in a future issue of Mecheleciv.



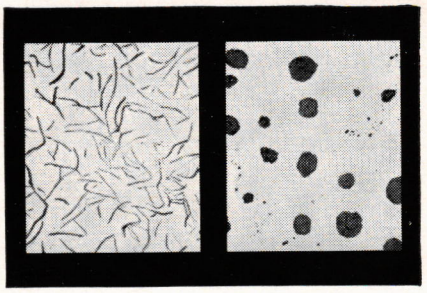
Repetitive flash photography makes it plain how ordinary (flake graphite) cast iron, when stressed, will break off short without bending.

Slow-Motion Proof

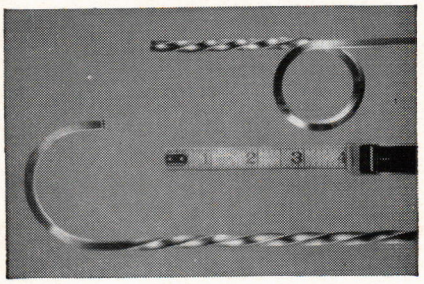
that Inco-developed Ductile Cast Iron has exceptional ductility—can be bent like mild steel



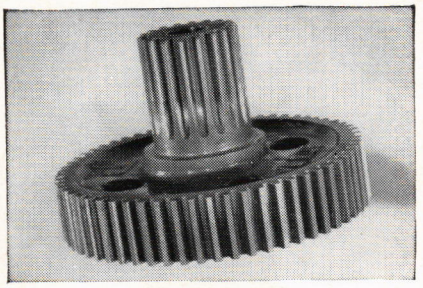
Under the watchful eye of the strobe camera, Ductile Cast Iron bends and bends. No break!



WHY Ductile Cast Iron is different: In conventional cast iron (left) the graphite is in flake form, making for brittleness. In Ductile Cast Iron (right) it's formed into tiny spheres — this makes for toughness, plus greater strength. (Magnified 100 times.)



HOW Ductile Cast Iron can be twisted and bent without breaking is shown above.



TODAY, Ductile Cast Iron is a material of many varied uses. Everything from pinking shears to plowshares—washing machine gears to jet plane parts! And industry is rapidly expanding its uses of this economical cast material.

An Inco development, Ductile Cast Iron is a new material that combines the best features of cast iron and steel.

Like cast iron, Ductile Iron has good fluidity. It's easy to cast. It machines well.

Like steel, Ductile Iron is strong *(the picture at left proves it)*. Its ductility is outstanding.

With Ductile Iron, industry is cutting costs on materials, production, maintenance. Write for "Ductile Iron, the Cast Iron that Can Be Bent." This booklet will be helpful to you in your engineering courses and also later on, when you face problems as a practicing engineer. The International Nickel Company, Inc., Dept. 128e, New York 5, N. Y.

INCO **International Nickel**

Producers of Inco Nickel, Nickel Alloys, Copper, Cobalt, Iron Ore, Tellurium, Selenium and Platinum, Palladium and Other Precious Metals

Here's how graduate engineers move up in the *GAS* industry ... the nation's sixth largest

The Gas industry—the sixth largest in the nation—has a total investment of over $15 billion. Last year the industry set a new all-time record in number of customers, volume of gas sold, and dollar revenue. In fact, Gas contributed 25% of the total energy needs of the nation as compared with 11.3% in 1940. The Gas industry is a major force in the growth development and economic health of this country.

There are many opportunities for you in the Gas industry. The industry needs engineers, and does not overhire. You won't be regimented. There's always room for advancement. With utility companies and with manufacturers of Gas equipment, there's a future for you as an engineer. Call your nearest Gas Utility. They'll be glad to talk with you about your opportunity in the Gas industry. *American Gas Association.*

Charles C. Ingram, Jr. became Vice President of Oklahoma Natural Gas Company in less than 15 years

CHARLES C. INGRAM, JR.
B.S. in Petroleum Engineering, 1940
University of Oklahoma

Charles Ingram has been Vice President of the Land and Geological Department of Oklahoma Natural Gas Company since June of 1955. Mr. Ingram joined the company immediately after his graduation from Oklahoma, and was soon called into service. Following his discharge, 5 years later, he rejoined the Engineering Department in Tulsa. He was quickly promoted to Assistant Chief Engineer and then took over the position of Superintendent of Gas Purchase and Reserves, and by 1954 was District Superintendent of the Oklahoma City district.

After 6 years with Lone Star Gas, Bill Collins took over a new job in a new field for the company

WILLIAM A. COLLINS, JR
B.S. in Mechanical Engineering, 1947
A & M College of Texas

Bill Collins is employed by the Lone Star Gas Company in Dallas as Coordinator of Air Conditioning and Utilization. Bill operates over 400 square miles in North Texas and Southern Oklahoma. Since joining Lone Star, Bill has worked primarily in the design, sales and installation of air conditioning equipment, with some time devoted to industrial gas applications. When it was found that a large scale air conditioning program requires close attention to design and installation as well as sales and service policies, a special department was organized in 1955. Bill was put in charge.

CAMPUS NEWS

SIGMA TAU

On December 8, 1956, Xi Chapter of Sigma Tau, the National Honor Society for Engineers, held its annual December banquet honoring its new initiates at the Occidental Restaurant.

This year the initiation was unique in that for the first time in the history of Xi Chapter the honor was conferred upon a woman. Barbara Jane Seehorn is the fifth woman to receive this honor in the Nation. She will graduate in June receiving a Bachelor of Science in Engineering Degree with a mathematics major.

Highlight of the initiation banquet was an address by Mr. M. H. Cook, one of the National Officers of Sigma Tau and Vice President of the Bell Laboratories in New York.

Professor B. C. Cruickshanks, Head of the Mechanical Engineering Department at George Washington University awarded the keys to the newly initiated members. Professor Cruickshanks is Advisor to Xi Chapter and was one of the founders of the Chapter.

The following students were those newly initiated:

Rexford G. Booth
Howard R. Davis
Robert W. Fulcher
George D. Hinshelwood
Joseph M. Mast
Richard W. Rumke
Frank Ryerson
Barbara J. Seehorn
Norman H. Street

Master of Ceremonies for the banquet and host for the evening was Irvin H. Schick, President of Xi Chapter.

Barbara Seehorn receiving Sigma Tau key from Prof. Cruickshanks.

ENGINEERS TAPPED FOR NEW HONORARY

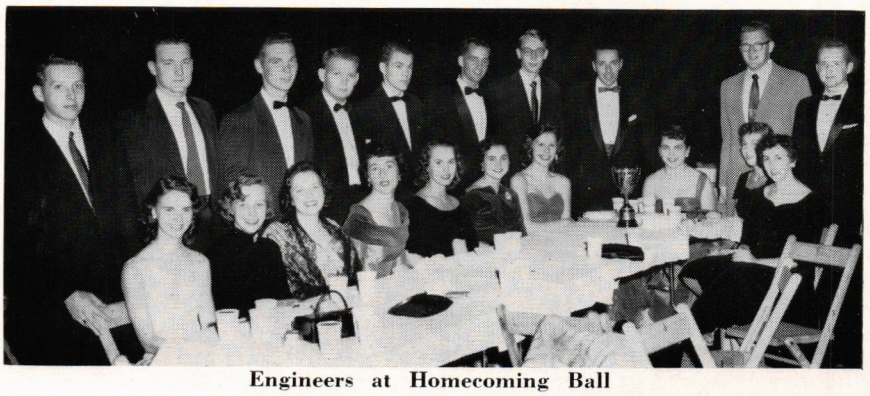
The School of Engineering was fairly well represented among the charter members of the newly founded Order of Scarlet. Albert Pinto, Bob Reining, Bob Shuken, and Ray Sullivan were tapped at the Dec. 14 performance of "Girl Crazy" in Lisner Auditorium. The Order of Scarlet was recently organized at this university as a sophomore and junior men's honorary. The new group honors men with a minimum Q.P.I. of 2.5 who have demonstrated an active interest in serving the University.

ENGINEER FLOAT WINS FIRST PRIZE

This time for the first time in several years, the Engineers' Council entered a float in the Homecoming Parade. Thanks to the inspired work of representatives of the various engineering societies and fraternities under the direction of Jerry Renton, Vice President of the Council, the float won first prize in its division. The prize was a cup which can be seen on the table in the Homecoming Ball picture below and which is now on display on the mantel in the Davis-Hodgkins House. We would have had a picture to go with the writeup except for the fact that we intended to take the picture after the parade. The last few minutes of the parade took place in a driving rain and the materials of which the float was constructed deteriorated rapidly.

HOMECOMING BALL

In keeping with the tradition established in past years, several of the engineers attended the Homecoming Ball with their dates or wives. Several couples are shown in the picture below grouped around the first prize award which the Engineers' Council won in the Homecoming Parade. Several other couples were at the Ball but had wandered off to dance or talk to friends at other tables when the picture was taken. For those who were there, copies of the picture are available in the Mechelecіv Office.



Engineers at Homecoming Ball

ALUMVIEWS

PRESIDENT'S MESSAGE

By Frank T. Mitchell
President, Engineer
Alumni Association

With the beginning of the New Year, the activities of the Engineer Alumni Association are moving into high gear. Highlighting our current program, of course, is the Association's active support of the 1957 Alumni Fund, now being conducted by the General Alumni Association among all graduates of the University.

As you will have noticed from the printed material sent to you by the 1957 Alumni Fund, the Tompkins Hall Equipment Fund has received "top billing," a recognitition of the great accomplishments of the school of Engineering as well as the critical needs at this moment. The Engineer Alumni Association has mobilized an active team of Engineer graduates in the Washington Metropolitan area to stimulate support of this fund by every graduate.

As additional asistance in this worthwhile project, members of the Association are contacting business firms in and around Washington to receive their support through the contribution of funds or equipment. All of us should "pitch in" on this project during the early part of this year.

While on the subject of funds, I am happy to report that the 1956-57 membership campaign of the Engineer Alumni Association resulted in the recruitment of 200 annual members, 20 new life members and 175 new subscribers to MECHELECIV. Thanks again for your continuing loyalty!

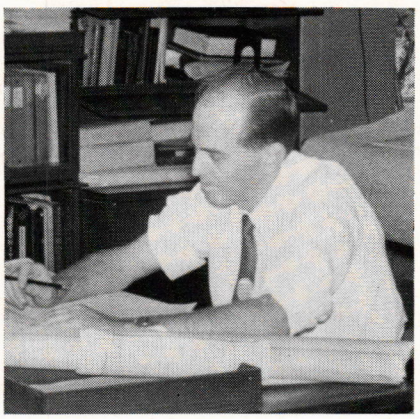
Members of the Association will soon receive notice of two other important events sponsored by the Engineer Alumni Association: the Open House at Tompkins Hall and the Howard Lectures featuring an outstanding engineer or scientist.

ALUMNI NOTES

MECHELECIV VISITS PEPCO

ELMER WHITLOCK (B.E.E. '54, A.I.E.E.) has been working at Pepco since he completed 7 years in night school. He is presently engaged in designing and laying out overhead distribution lines, preparing estimates and construction plans for extensions or rearrangements of electrical distribution facilities for commercial and residential customers, and preparing calculations for determining voltage drops, starting currents for motors, fuse sizes and proper guying.

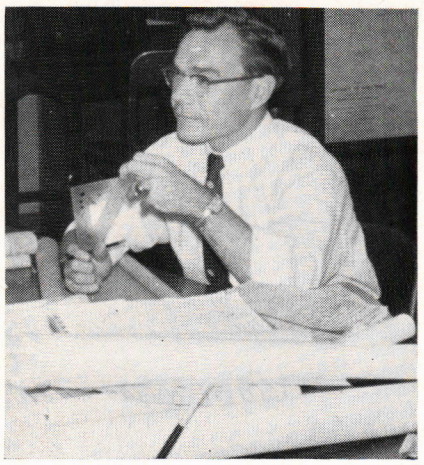
Mr. Whitlock's hobby is duckpins, and he scores well for his team at Pepco, the Dead Ends.



Mr. Proctor

WILLIAM PINDELL, JR. (B.E.E. '53, A.I.E.E.) is employed as Area Engineer, distribution Engineering Division, Potomac Electric Power Co. He supervises engineering work in a specific geographical area. His job includes distribution design work necessary to serve homes, apartments, shopping centers, and industrial establishments. He also supervises 4 KV and 13 KV feeder rearrangements and extensions and street light installation.

Mr. Pindell is married and has a son Steve, age 11.



Mr. Whitlock

AUTHUR EDWIN PROCTOR (B.E.E. '53, Sigma Tau) works for the Potomac Electric Power Co. as Assistant Engineer. His present job is concerned with 4 KV distribution and customer work plus some high tension and network installation; until a year ago, he worked on 69 KV and 40 KV underground transmission. Mr. Proctor is married and has a son, Stephen, age seven.

In August of 1956 he received a reserve commission in the Navy as Lt. J. G. Most of his time is spent on overtime at work, although he finds a moment now and then to work on an old TV set which is used as a second set.

Mr. Pindell

Hitch your future to a HELICOPTER...

it's going places and so can you

Although acclaimed everywhere as the world's most versatile aircraft, helicopters have had only a few short years to prove it. A product of your generation, they are . . . in fact . . . *younger* than you are.

Like you, they face a future that is at once challenging and promising, but the exciting details of that future remain to be discovered and worked out.

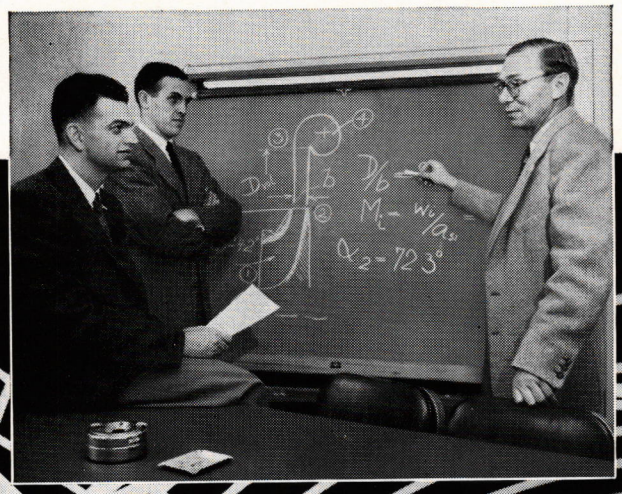
If you expect to be a graduate engineer shortly, all this can be most important to you. Sikorsky Aircraft, the company that pioneered helicopters, is moving into high gear . . . going all out to keep pace with ever-increasing military and commercial requirements. Quite naturally, the world looks to Sikorsky to design and build the helicopters of tomorrow. And for the creative engineering, for the imagination, for the technical abilities that the future will demand . . . Sikorsky Aircraft looks to *you*.

We would welcome the opportunity to give you a more complete picture of our company . . . and to see if there is a place in that picture for you. The next step is yours. Take that step and write to Mr. Richard Auten, Personnel Department.

SIKORSKY AIRCRAFT

ONE OF THE DIVISIONS OF UNITED AIRCRAFT CORPORATION • Bridgeport 1, Connecticut

To the engineer who intends to blaze *new* trails...



Six inch long compressor-turbine assembly in a midget AiResearch air expansion refrigeration unit which operates at 100,000 r.p.m., can drop temperature more than 600° F. in a second.

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TRANSISTORS

(Continued from page 15.)

The numerical value of these parameters may be determined by either finding the slopes of the characteristic curves at the operating points or by measuring them directly by experimental means.

The interpretation of equations (1) and (2) yields a two generator eqivalent circuit illustrated in Figure 2 (a). The circuit may be verified by observing that the above equations are merely the input and output mesh equations.

Admittance Equivalent Circuit

Assuming that v_1 and v_2 are the independent variables, the admittance equations are

$$i_1 = y_{11}v_1 + y_{12}v_2 \qquad (3)$$

$$i_2 = y_{21}v_1 + y_{22}v_2 \qquad (4)$$

where the short circuit admittances are defined as

$$y_{11} = \left(\frac{i_1}{v_1}\right)_{v_2},\ y_{12} = \left(\frac{i_1}{v_2}\right)_{v_1},$$

$$y_{21} = \left(\frac{i_2}{v_1}\right)_{v_2},\ y_{22} = \left(\frac{i_2}{v_2}\right)_{v_1}$$

The basic equivalent circuit which follows from equations (3) and (4) is illustrated in Figure 2 (b). Again notice that these equations are the input and output nodal equations.

Hybrid Equivalent Circuit

Probably the most useful parameters in terms of ease of measurement are the hybrid circuit parameters. As the name implies it is a series-parallel combination resulting in an input that appears as an impedance in series with a voltage generator and an output that consists of a current generator shunted by an admittance.

$$v_1 = h_{11}i_1 + h_{12}v_2 \qquad (5)$$

$$i_2 = h_{21}i_1 + h_{22}v_2 \qquad (6)$$

where the parameters are defined as

$h_{11} = \left(\frac{v_1}{i_1}\right)_{v_2}$, input impedance with output short circuited

$h_{22} = \left(\frac{i_2}{v_2}\right)_{i_1}$, output admittance with input open

$h_{21} = \left(\frac{i_2}{i_1}\right)_{v_2}$, output to input current ratio with output short circuited

$h_{12} = \left(\frac{v_1}{v_2}\right)_{i_1}$, input to output voltage ratio with the input open

Figure 2 (c) represents the equivalent circuit of a transistor utilizing hybrid parameters. It is interesting to note that a series hybrid equivalent circuit is commonly used to represent the vacuum tube. The small variations equation is

$$v_2 = H_{21}v_1 + H_{22}i_2$$

where the hybrid parameters are defined

$H_{21} = \left(\frac{v_2}{v_1}\right)_{i_2}$, or $-\mu$ (mu)

$H_{22} = \left(\frac{v_2}{i_2}\right)_{v_1}$, or the variational plate resistance, r_p

Device Parameters

The equivalent circuits discussed thus far have the obvious disadvantage of requiring two generators. Certain modifications of the four terminal networks reduce the number of generators and at the same time produces a circuit that utilizes device parameters. Some of these parameters may be directly determined by knowing the physical properties of the semiconductor.

The modified Tee network is perhaps the most well known of the transistor equivalent circuits. Historically, it was originally developed for the point contact transistor and later applied to the junction transistor. Figure 3 shows this equivalent network where r_e (emitter resistor), r_b (base resistor), r_c (collector resistor), and α (alpha-current gain) or r_m are the device parameters. Since node "n" is wholly within the transistor, one can readily see why these parameters cannot be directly measured by electrical means. The common base configuration has been chosen for simplicity, however the other configurations can be easily obtained. Since the device parameters are independent of the configuration used, the equivalent circuit is merely rearranged by the arbitrary choice of which electrode is to be grounded.

The most common method used to determine device parameters is by conversion from h parameters. Only simple calculations are necessary to make the conversion.

High Frequency

Soon after the junction transistor was developed it was observed that the terminal voltage and current depended on the signal frequency. The search for a frequency independent device parameter resulted in the addition of a capacitance C_c across the collector resistance as indicated by the dotted lines in Figure 3. Physically this parameter is associated with the junction capacitance between the base and collector. A parameter which is often included in the specifications of a transistor is the so called alpha cut-off frequency. It is defined as the frequency for which the short circuit current amplification factor, alpha, has decreased in magnitude to 0.707 times its low frequency value.

Conclusion

In the above discussion an attempt has been made to explain the circuit and device parameters and how they appear in the various equivalent circuits. On the basis of its ease of measurement the hybrid equivalent circuit is probably the best network for the determination of circuit parameters.

The equivalent circuits discussed are by no means comprehensive. The actual transistor may contain more elements than are included in the modified Tee model. However, if we increase the complexity of the device equivalent circuit to make it more accurate, it becomes less useful for circuit design.

Another page for **YOUR STEEL NOTEBOOK**

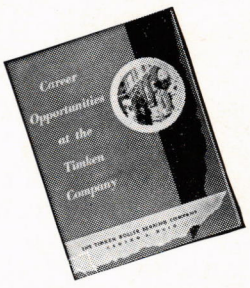
How to shape a vacuum cleaner like a basketball

TO make their new vacuum cleaner functional as well as handsome, engineers at the Hoover Company developed a nearly round design. The problem was how to produce it economically.

The first ring dies they used to produce the shape from sheet steel picked up bits of steel and scored following pieces. Production had to be shut down while the dies were polished. Finishing costs ran high.

After studying the problem, Timken Company metallurgists recommended a special analysis of tool steel for the dies. Graph-Mo®, developed by the Timken Company. Minute particles of graphite in Graph-Mo act as a built-in lubricant—keep parts from galling. Diamond-hard carbides in its structure make it wear, give it longer life.

With the new Graph-Mo dies, downtime was cut 50%. Production rolled smoothly. The dies outlasted previous ones 3 to 1. It's another example of how Timken pioneering in fine alloy steels helps solve knotty industrial problems.



Want to learn more about steel or job opportunities?

For help in learning more about steel, write for your free copy of "The Story of Timken Alloy Steel Quality". And for more about jobs at the Timken Company, send for a copy of "Career Opportunities at the Timken Company". Address: The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN *Fine Alloy* STEEL

TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

Tomorrow's Transportation

(Continued from page 13.)

With these basic principles set forth let us see what regulations and restrictions the pilot of a small, personal helicopter must obey. The Air Traffic Rules of the C.A.A. govern the flight of all aircraft including helicopters. Their basic purpose is the safety and protection of pilot, passengers, and aircraft and the persons and property over which these aircraft fly. The Air Traffic Rules are lengthy and general in nature and therefore will not be quoted directly. It is sufficient to point out that at five different points in the articles on minimum safe altitudes and visibility the rules mention the great maneuverability and safety of the helicopter and except it from many of the altitude and visibility restrictions placed on conventional fixed wing aircraft. These rules do not bar the helicopter from flight over cities or congested areas and thus it is quite probable that the personal helicopter of the near future will take over many of the duties of present day automobiles.

Let us now see what progress has been made toward providing the general public with a practical personal helicopter. The first research program solely for the development of a one man, personal helicopter was begun in 1945 by Hoppi-Copters Inc. The initial result was a coaxial, double rotor, back strap model. This machine utilized the principles of contrarotating rotors as a means of eliminating torque. The back strap model proved impractical and further development resulted in the machine shown in the picture with landing gear and pilot seat and a single stick control. The engine was 40 hp., air cooled. The rotor diameter was 16 ft. The empty weight was 200 lbs. with a useful load of 250 lbs. This craft was flown in free flight tests up to 10 feet. It is now in a damaged condition and has not been worked on since 1949. The company was reorganized this year and plans an extensive development program with production to follow certification by the C.A.A.

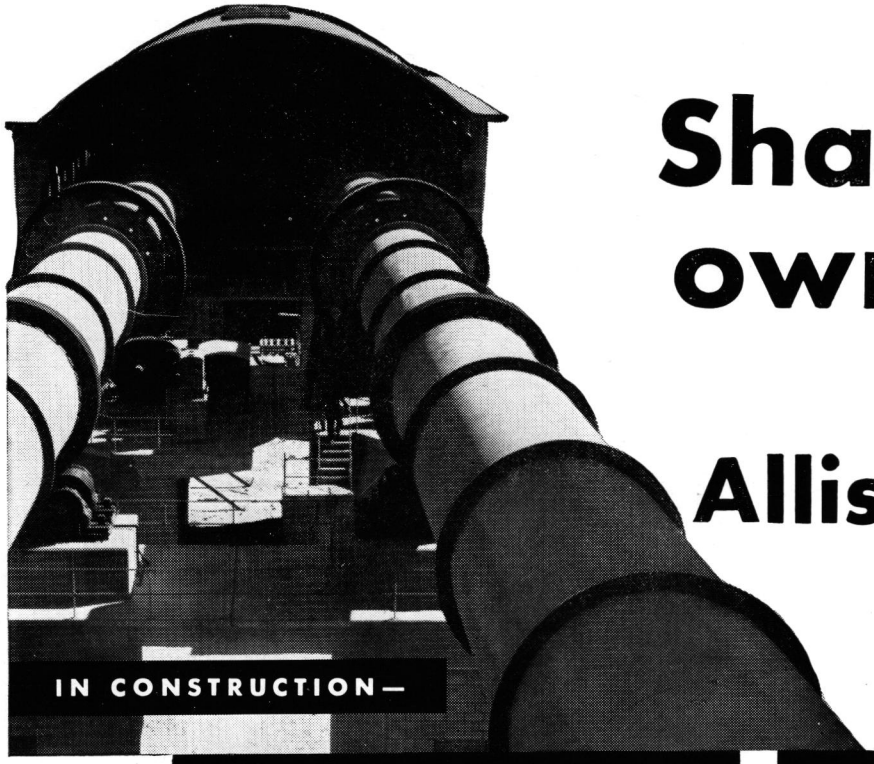
Hiller Helicopters of Palo Alto, California, has as its ultimate goal the development of a cheap, mass produced, personal helicopter. In 1950 a significant step was taken toward this goal with the first flight of the Hiller "Hornet." This craft is a small two place helicopter which utilizes small ram jet engines on the tips of its rotor blades. This type of power eliminates the complex transmission systems required of conventional engine power and also eliminates torque. The small ram jet engines, which were developed by Hiller, weigh 13 lbs. and develop 45 hp. each. Their main disadvantages are noise and high fuel consumption. The "Hornet" uses a two bladed 35 ft. rotor. It has a useful load of 536 lbs., a speed of 60 knots and a range of 28 miles with a 50 gal. fuel capacity. It has been produced in limited quantities for evaluation by the Army and Navy. Although commercial production is not planned in the near future, the estimated production cost is $5,000. This compares quite favorably with the $35,000 cost of the cheapest helicopter now in production.

The advent of atomic war has created the need for increased mobility of the foot soldier. Such tasks as liaison, reconnaissance and many others could be aided through the use of some form of aircraft which could serve the same purpose as a motorcycle does on the ground. With this in mind the Office of Naval Research and Hiller Helicopter combined their efforts in the development of the "Flying Platform." This unique device utilizes the principles of the ducted fan to produce lift. Some lift is also produced due to the increase in pressure caused by the flow of air over the upper lip of the duct. The platform uses two 40 hp. engines belt connected to contrarotating propellors. The pilot maintains directional control by leaning in the direction of desired flight. This machine is strictly a research device and more development is required before it is put to practical use. Since it uses propellors instead of rotors it cannot autorotate in the event of engine failure.

The De Lackner Helicopter Co. has developed a one man helicopter known as the "Aerocycle" for the same uses as the "Flying Platform." It uses two contrarotating rotors attached beneath the pilots platform. It is powered by a 40 hp. Mercury outboard motor engine. Landing gear is composed of 5 plastic bags which allow it to land on water as well as land. The "Aerocycle" has a payload of 300 lbs., a maximum speed of 65mp., and a range of 150 miles. The Army leased 12 "Aerocycles" for testing this past summer.

Both the "Flying Platform" and the "Aerocycle" may be flown by persons having no previous flying experience. The greatest problem is the psychological one of overcoming the fear of tipping over. This fear is groundless in that both vehicles are quite stable and will not tip.

There are many other small helicopter projects under way in this country. The ones I have described are the most advanced and are the best candidates for the title "Model T of the Air."



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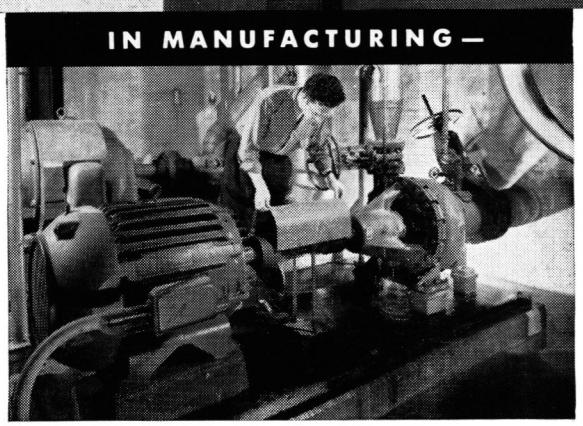

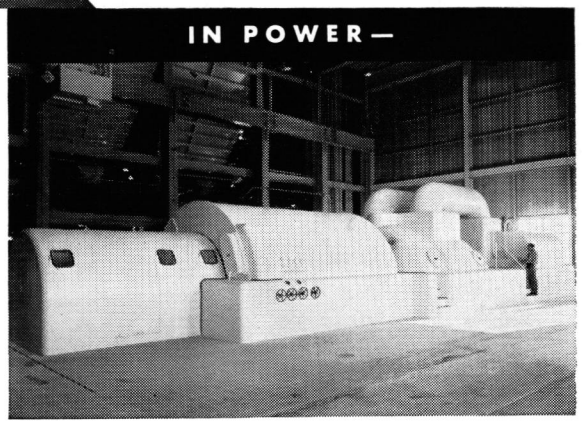

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Allis-Chalmers Graduate Training Course allows you to develop skill through application of theoretical knowledge. For example:

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—and many more make up a course designed to develop industrial leaders.

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The Course—Offers maximum of 24 months' training. Established in 1904. Recognized as a model for industry since that time.

Optional Program—You plan your own program and may revise it as your interests change. Competent counselors are always available.

Objectives—Program is designed to put the right man in the right job and develop men of management caliber.

Results—Many members of Allis-Chalmers management team are graduates of this program.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

5044

Slipstick Slapstick

Then there were the two little ink drops who were very blue because their pappy was still in the pen finishing out a sentence.

Voice from back of room during quiz: "Are you sure this test question is in the book?"

Instructor: "Certainly it is."

Voice: "Well I can't find it."

Wine, women and song are getting to be too much for me; guess I'll have to quit singing.

Two lunatics were playing a little game.

"What have I got here?" asked one, with his hands cupped.

"Three Navy Patrol bombers." said the other.

The first one looked carefully into his hands, "Nope."

"The Empire State Building?"

"Nope."

"The Philadelphia Symphony Orchestra?"

The first one looked into his hands again and said slyly, "Who's conducting?"

"Porter, get me another glass of ice water."

"Sorry sir, but if I take any more, that corpse in the baggage car ain't gonna keep."

Upon being sentenced, Rastus muttered something that sounded suspiciously like an oath.

"R e p e a t that," thundered the judge.

"Ah didn't say nothin', Jedge."

"You did and I want to know what it was — repeat it."

"Well, all ah says, Jedge, was: 'God am de Jedge.' "

Once upon a time there lived in the South a man who worked all day in a stove factory, making stoves. He was, in fact, a stover, i.e., one who stoves. Now this stover's boss not only ran the stove factory but also (this was in pre-Civil war days) picked up loose change by trading in the slave market. He kept his slaves in the basement of the stove factory, right under where the stover worked.

One day the boss brought in a slave who was sick — had a high temperature (106°F.) and was delirious. The slave kept shouting and ranting all day, which made it very hard for the stover to work. So when he, the stover, went home that night, his wife said, "My dear, you look tired."

"So would you look tired," he replied, "If you had been stoving over a hot slave all day."

"Wanna fly?" asked Mickey B. of the sweet young Angel's Flight member who was asking all the questions.

"My goodness," she said, "I certainly would."

"Just a minute," said our hero, "I'll catch one for you."

"I can't marry him, mother, he's an atheist and doesn't believe there is a hell."

"Marry him, my dear, and between the two of us we'll convince him."

Customer: "I'd like 15 cents worth of quinine, please."

Druggist: "Here you are, sir."

Customer (a moment later): "Help, I'm poisoned."

Druggist (looking at the box): "You're right, that stuff's strychnine. That'll be 10 cents extra. Pay me quick, that stuff works fast."

Ruth rode in my new convertible
On the seat in back of me.
I hit a bump at fifty-five
And rode on ruthlessly.

Woman: "Son, can you direct me to the bank?"

Small Boy: "Yess ma'am, for a quarter."

Woman: "Isn't that mighty high?"

Boy: "No ma'am. Not for a bank director."

Ashes to ashes, dust to dust;
If it weren't for paint,
Women would rust.

Arts Student: "I have a splinter in my finger."

Engineer: "Been scratching your head?"

Engineer: "What well developed arms you have."

Coed: "Yes, I play tennis."

Engineer: "You ride horseback, too, don't you?"

The Southern father was introducing his family of boys to a visiting governor.

"Seventeen boys," exclaimed the father, "and all Democrats—except John, the little rascal. He got to reading.

Freshman: "What does 'Fantasy' means?"

Senior: "A story in which the characters are ghosts, goblins, virgins, and other supernatural characters."

Professor: "This exam will be conducted on the honor system. Please take three seats apart and in alternate rows."

Then there was the fellow who had a hobby of collecting rocks and putting them in his bathroom. He had rocks in his head.

LETTERS TO THE EDITOR

Readers wishing to express an opinion or ask a question of general interest are invited to mail their letters to:

Editor

Mecheleciv Magazine

The George Washington University

Washington 6, D. C.

A pseudonym or initials may be used when the letter is printed but all letters must be accompanied by the writer's name and address. The Board of Editors reserves the right to edit lengthy letters.

EDITOR:

I'm in favor of your policy of having each branch of engineering represented in your feature articles.

H. E. Hutto

Ed.: *That seemed to be the consensus of opinion. We'll keep it up.*

EDITOR:

The articles "Hardness Testing" and "Service Your Own TV" in the October issue are very good. Metallurgy articles on steel would interest me.

E. O. Stengard

Ed.: *We'll see if one of our M.E.'s will do such an article.*

EDITOR:

. . . a fine mag. Gets better yearly. Unusual commentary, but my wife enjoys it too.

Ed.: *Tell her to watch for the April issue. That's the one to be published by the distaff side of our staff for their feminine friends among our readers.*

HELP WANTED

Art Editor:

Knowledge of artwork desirable but not necessary. Must have initiative and enthusiasm for the job. Main duties will concern obtaining artwork for the School of Engineering magazine at an outstanding eastern University. Pay—valuable experience and self-satisfaction with a job well done.

Rewrite Men (or Women):

Must handle grammar and punctuation well. Area of responsibility encompasses the rewriting of technical papers to make them of general interest so as to attract the largest segment of the readers of a college technical magazine. Any previous experience in the art of converting the cold facts, figures, and formulae of "engineerese" into more palatable form would be valuable. Compensation difficult to evaluate in dollars and cents. Need not necessarily be one of the fold of engineers.

Authors:

Necessary to fill continuing and expanding requirement for articles for college technical periodical. Articles need not be technical but should be associated, at least remotely, with the field of engineering. Humorous material especially desirable. Technical articles stand better chance of being published if accompanied by finished artwork. Freshmen and sophomore contributors, if interested, can work their way up the ladder of the staff of the magazine.

Anyone interested in filling any of the above positions or any of the other jobs on *Mecheleciv* are requested to drop in at the *Mecheleciv* office on the second floor of the Davis-Hodgkins House or contact one of the staff members.

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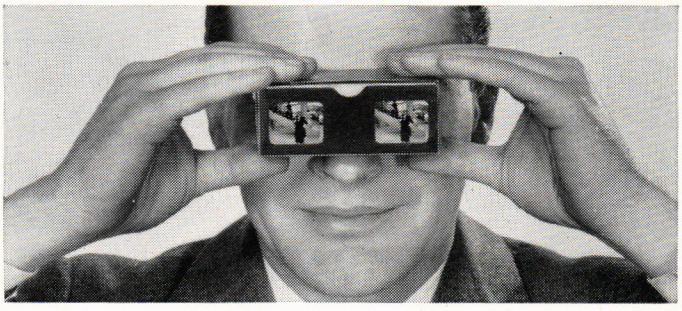

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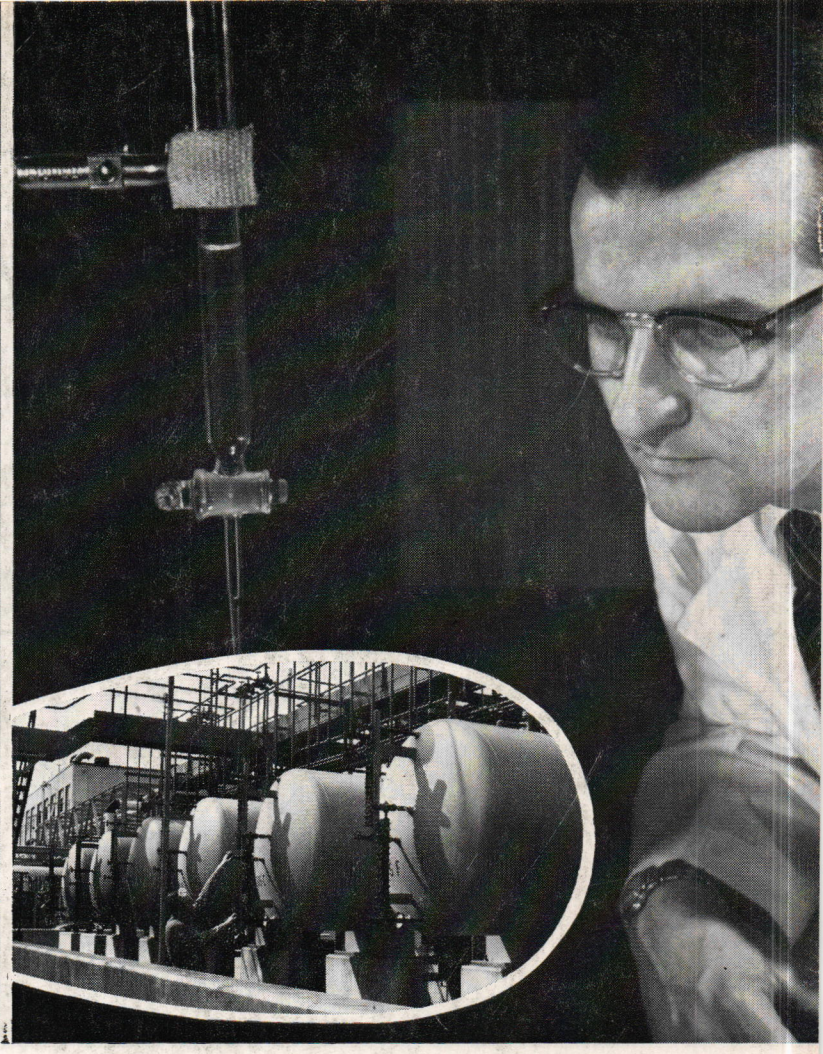

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